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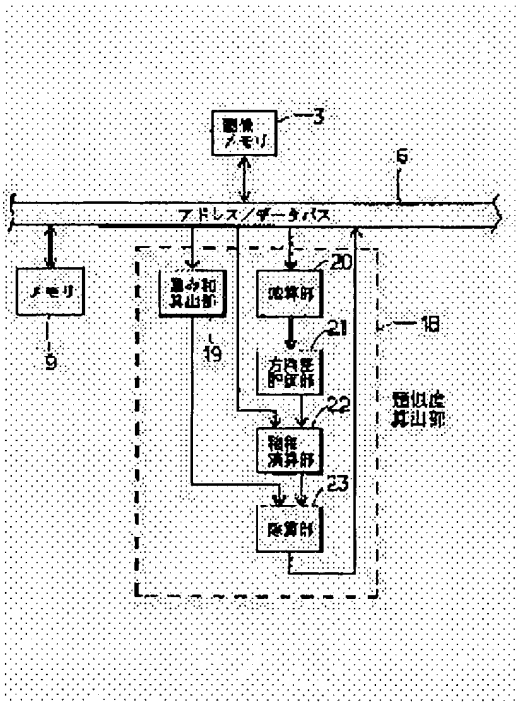
(54) DEVICE AND METHOD FOR CALCULATING SIMILARITY DEGREE AND POSITION DETECTOR USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To accurately calculate the degree of similarity between an input image and a model image by adding a value, while weighting it, with which the difference of density gradient direction between each picture element of the input image and the correspondent picture element of the model is evaluated, corresponding to the weight provided from the model.

SOLUTION: A density gradient direction Iθ (x, y) at each picture element of the input image fetched into an image memory 3 is found and stored in a memory 9 by the density gradient direction calculation part of an image processor. Then, a subtraction part 20 and direction difference evaluation part 21 of a similarity degree calculation part 18 find a value f [Iθ (x, y)-Mθ (x, y)] with which the difference of density gradient direction is evaluated between the density gradient direction Iθ (x, y) of this input image and a density gradient direction Mθ (x, y) at each correspondent picture element of the model previously stored in the memory 9. Then, a product-of- sums arithmetic part 22 adds while weighting this evaluated value corresponding



to weight Mw (x, y) provided from the model and a division part 23 divides this added value with the sum of weight calculated by a sum-of-weight calculation part 19 so that the degree of similarity can be found.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to an input picture, a model, the degree calculation equipment of similar that computes the degree of similar, a method, and the position detection equipment using it.
[0002]
[Description of the Prior Art] Conventionally, the normalization cross-correlation is known as a method of computing the degree of similar of shade pictures with little influence to lighting change (an image-analysis handbook, Mikio Takagi and Akihisa Shimoda editorial supervision, University of Tokyo Press). The composition of the conventional image processing system using this normalization cross-correlation is shown in drawing 23 . The camera 1 with which this image processing system picturizes the specified substance, and A/D converter 2 which changes into a digital signal the picture which took a photograph, The image memory 3 which memorizes the digitized picture, and D/A converter 4 which changes a digital image into an analog signal for a display, CRT display 5, the address/data bus 6, and the timing-control section 7, It has CPU8 which performs various processings of the incorporation of an input picture, a display, the degree calculation of similar, etc., and control, the memory 9 which memorizes the image data for the degree calculation of similar, the degree calculation section 10 of similar, and the threshold judging section 11.
[0003] The above-mentioned degree calculation section 10 of similar is equipped with the covariance calculation section 12, the standard deviation calculation section 13, the addition section 14, and the division section 15 as shown in drawing 24 . In this image processing system, the analog video signal outputted from the camera 1 is A/D converter 2, and after A/D conversion is carried out synchronizing with the timing signal from the timing-control section 7, it is memorized by the image memory 3 as a shade picture. After the input picture memorized by the image memory 3 is changed into an analog signal through D/A converter 4, it is displayed on CRT display 5. On the other hand in the degree calculation section 10 of similar, the degree of similar of the input picture memorized by the image memory 3 and the model picture beforehand memorized by memory 9 is computed, and memory 9 memorizes. Comparison with the degree of similar memorized by memory 9 and the threshold set up beforehand is performed in the threshold judging section 11, and the judgment of OK/NG is carried out. The result is memorized by memory 9. Delivery of the data between each module is performed through the address / data bus 6. Moreover, invocation command issue of each module is performed by CPU8.
[0004] In the degree calculation section 10 of similar, if the size of a model picture and an input picture is set to (mx, my) and concentration of I (x y) and a model picture is set to M (x y) for the concentration value of an input picture, the degree of similar (CC) will be computed by the following formulas.
[0005]
[Equation 1]

$$CC = \frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{I(x,y)-\bar{I}\}\{M(x,y)-\bar{M}\}}{\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{I(x,y)-\bar{I}\}^2}\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{M(x,y)-\bar{M}\}^2}}$$

$$\bar{I} = \frac{1}{mx \times my}\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1} I(x,y)$$

ここで、

$$\bar{M} = \frac{1}{mx \times my}\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1} M(x,y)$$

[0006] The concentration value M (x y) of the model picture memorized by the concentration value I (x y) and memory 9 of the input picture memorized by the image memory 3 is incorporated through the address / data bus 6 by the degree calculation section 10 of similar. It sets in the covariance calculation section 12, and is the covariance [0007] of I (x y) and M (x y).

[Equation 2]

$$\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{I(x,y)-\bar{I}\}\{M(x,y)-\bar{M}\}$$

[0008] It ******. Moreover, it sets in the standard deviation calculation section 13, and is the standard deviation [0009] of I (x y).

[Equation 3]

$$\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{I(x,y)-\bar{I}\}^2}$$

および、M（x、y）の標準偏差

$$\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{M(x,y)-\bar{M}\}^2}$$

[0010] It ******. It sets in the addition section 14 and is the product [0011] of the standard deviation of I (x y), and the standard deviation of M (x y).

[Equation 4]

$$\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{I(x,y)-\bar{I}\}^2}\sqrt{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{M(x,y)-\bar{M}\}^2}$$

[0012] It ******. In the division section 15, a normalization cross-correlation value (CC) is computed and memory 9 memorizes as a degree of similar of a model picture and an input picture.

[0013]

[Problem(s) to be Solved by the Invention] The technique of asking for the above-mentioned conventional normalization cross-correlation is the matching method eternal under movement of a concentration gradient, or expansion and contraction. However, when a linear-transform relation is not realized, the trouble that the ratio of the product of each standard deviation to the covariance of a model picture and an input picture is large, the degree of similar becomes small and stable pattern recognition cannot be performed by the bird clapper is between model pictures, such as shading and background

change, and an input picture. For example, when the degree of similar of an input picture from which a part of background of a model picture changed, and a model picture was calculated like drawing 25 , and the degree of similar is set to about 0.61 and it compares with the correlation value 1.0 of model pictures, it falls considerably and stable recognition cannot be performed.

[0014] This invention is made paying attention to the above-mentioned trouble, and the degree calculation of similar of an input picture and a model picture from which a part of background of a model picture changed is also aimed at offering the equipment and the method of achieving results with a sufficient precision.

[0015]

[Means for Solving the Problem and its Function] The degree calculation equipment of similar concerning the claim 1 of the claim of this application Between a direction calculation means of a concentration gradient to ask for direction of concentration gradient Itheta (x y) in each pixel of an input picture, direction of concentration gradient Itheta (x y) of this input picture, and direction of concentration gradient Mtheta (x y) of the pixel to which a predetermined model corresponds A direction evaluation value calculation means of a concentration gradient to ask for value f {Itheta(x y)-Mtheta (x y)} which evaluates the difference of the direction of a concentration gradient, adding the evaluation value which carried out weighting to the weighting means which carries out weighting to this evaluation value by the weight MW (x y) obtained from the aforementioned predetermined model -- the degree of similar [0016]

[Equation 5]

$$R = \sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{ M_w(x, y) \cdot f \{ I_\theta(x, y) - M_\theta(x, y) \} \}$$

[0017] It has a means to ******. Moreover, a direction calculation means of a concentration gradient to ask for direction of concentration gradient Itheta [in / each pixel of an input picture / in the degree calculation equipment of similar concerning a claim 2] (x y), Between direction of concentration gradient Itheta (x y) of this input picture, and direction of concentration gradient Mtheta (x y) of the pixel to which a predetermined model corresponds A direction evaluation value calculation means of a concentration gradient to ask for value f {Itheta(x y)-Mtheta (x y)} which evaluates the difference of the direction of a concentration gradient, It is degree of similar R [0018] by carrying out the division of this aggregate value by which weighting was carried out to the weighting means which carries out weighting to this evaluation value by the weight MW (x y) obtained from the aforementioned predetermined model, and an addition means to add the evaluation value which carried out weighting, in the weight sum total.

[Equation 6]

$$R = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{ M_w(x, y) \cdot f \{ I_\theta(x, y) - M_\theta(x, y) \} \}}{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} M_w(x, y)}$$

[0019] It has a means to ******. Moreover, in a claim 1 or a thing according to claim 2, the concentration-gradient intensity of a model picture is being used for the degree calculation equipment of similar concerning a claim 3 as weight of a weighting means. Moreover, the value which evaluated the degree calculation equipment of similar concerning a claim 4 in the claim 1, the claim 2, or the thing according to claim 3 is made into the cosine of the difference of the direction of a concentration gradient.

[0020] Moreover, the value which evaluated the degree calculation equipment of similar concerning a claim 5 in the claim 1, the claim 2, or the thing according to claim 3 will be set to 1 if the difference of the direction of a concentration gradient is a value [predetermined / containing 0 degree] within the limits, if it is within the limits predetermined / other /, it will be set to -1, and if it is the other

predetermined value within the limits, it is set to 0. Moreover, the weight value to which weighting of the degree calculation equipment of similar concerning a claim 6 was carried out by the weighting means in the claim 1 or the thing according to claim 2 is made to perform the degree calculation of similar only to the pixel beyond a predetermined value.

[0021] Moreover, a direction calculation means of a concentration gradient to ask for direction of concentration gradient Itheta [in / each field of an input picture / in the degree calculation equipment of similar concerning a claim 7] (x y), Between direction of concentration gradient Itheta (x y) of this input picture, and direction of concentration gradient Mtheta (x y) of the field where a predetermined model corresponds A direction evaluation value calculation means of a concentration gradient to ask for value f {Itheta(x y)-Mtheta (x y)} which evaluates the difference of the direction of a concentration gradient, It is degree of similar R [0022] by carrying out the division of this aggregate value by which weighting was carried out to the weighting means which carries out weighting to this evaluation value by the weight MW (x y) obtained from the aforementioned predetermined model, and an addition means to add the evaluation value which carried out weighting, in the weight sum total.

[Equation 7]

$$R = \frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\left[M_w(x,y)\cdot f\left\{I_\theta(x,y)-M_\theta(x,y)\right\}\right]}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}M_w(x,y)}$$

[0023] It has a means to ******. moreover, the degree calculation method of similar concerning a claim 8 -- each pixel of an input picture -- direction of concentration gradient Itheta (x --) It is the degree of similar of two shade pictures [0024] by asking for y), carrying out weighting of the value which evaluated the difference of direction of concentration gradient Mtheta (x y) of a model, adding it by the weight MW (x y) obtained from a predetermined model, between the pixels to which a predetermined model corresponds, and carrying out a division in the weight sum total.

[Equation 8]

$$R = \frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\left[M_w(x,y)\cdot f\left\{I_\theta(x,y)-M_\theta(x,y)\right\}\right]}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}M_w(x,y)}$$

[0025] It ******. Moreover, as weight obtained from a model, the degree calculation method of similar concerning a claim 9 is made into the concentration-gradient intensity of a model picture, and computes the degree of similar of two shade pictures. Moreover, in a method according to claim 8, as an evaluated value, the degree calculation method of similar concerning a claim 10 is made into the cosine of the difference of the direction of a concentration gradient, and computes the degree of similar of two shade pictures.

[0026] Moreover, the degree calculation method of similar concerning a claim 11 will be set to 1 if the difference of the direction of a concentration gradient is a value [predetermined / containing 0 degree] within the limits as an evaluated value in a method according to claim 8, if it is the other predetermined value within the limits, it will be set to -1, if it is the other predetermined value within the limits, will be set to 0 and will compute the degree of similar of two shade pictures. Moreover, a model picture storage means by which the position detection equipment concerning a claim 12 memorizes a model picture, An input picture storage means to memorize an input picture, and the scanning means to which the impaction efficiency of the model picture is carried out within an input picture, It has the positioning means which make the claim 1 which computes the degree of similar of a model picture and the input picture of the position in this scanning process, the degree calculation equipment of similar according to

claim 2, and the position of the highest input picture of the computed degree of similar the position of the model in an input picture.
[0027] Moreover, the degree calculation equipment of similar concerning a claim 13 is set to the thing concerning a claim 1, a claim 2, or a claim 7. A direction storage means of a concentration gradient to memorize the direction of a concentration gradient in each pixel of two or more model pictures, A concentration-gradient on-the-strength storage means to memorize the concentration-gradient intensity in each pixel of the aforementioned two or more model picture, It has a direction calculation means of a representation concentration gradient aforementioned to compute the direction of a representation concentration gradient from a concentration gradient, and a representation concentration-gradient on-the-strength calculation means to compute representation concentration-gradient intensity from the aforementioned concentration-gradient direction and the aforementioned concentration-gradient intensity.
[0028] Moreover, the degree calculation method of similar concerning a claim 14 memorizes the direction of a concentration gradient in each pixel of two or more model pictures, memorizes the concentration-gradient intensity in each pixel of the aforementioned two or more model picture, and computes [aforementioned] the direction of a representation concentration gradient from a concentration gradient, and it is made to compute representation concentration-gradient intensity from the aforementioned concentration-gradient direction and the aforementioned concentration-gradient intensity in a claim 9 and a method according to claim 10 or 11.
[0029] Moreover, the degree calculation equipment of similar concerning a claim 15 asks for the average of the direction of a concentration gradient of two or more pictures as a direction of a representation concentration gradient in a thing according to claim 13. Moreover, the degree detection equipment of similar concerning a claim 16 searches for the additive means of the concentration-gradient intensity of two or more pictures as representation concentration-gradient intensity in a thing according to claim 13.
[0030] Moreover, the degree calculation equipment of similar concerning a claim 17 asks [for which it asked from the average of the direction of a concentration gradient of the direction of a concentration gradient of two or more pictures, concentration-gradient intensity, and two or more pictures] for the arithmetical mean of the direction component of a representation concentration gradient of concentration-gradient intensity from a representation concentration gradient as representation concentration-gradient intensity in a thing according to claim 13. Moreover, the degree detection equipment of similar concerning a claim 18 finds the length of the vector which uses the average of the sine of a concentration gradient to [of two or more pictures] the direction of a concentration gradient, and the average of a cosine as a component, and asks for the product of the value and representation concentration-gradient intensity of a claim 17 as new representation concentration-gradient intensity.
[0031] Moreover, a direction calculation means of a concentration gradient by which the degree calculation equipment of similar concerning a claim 19 asks for the direction of a concentration gradient in each pixel of two or more pictures beforehand, A concentration-gradient on-the-strength calculation means to compute the concentration-gradient intensity in each pixel of the aforementioned two or more pictures, A direction calculation means of a representation concentration gradient aforementioned to compute the direction of a representation concentration gradient from a concentration gradient, A representation concentration-gradient on-the-strength calculation means to compute representation concentration-gradient intensity from the aforementioned concentration-gradient intensity, The storage section which creates and memorizes ******** model data, the direction of a concentration gradient of an input picture, and concentration-gradient intensity between the directions of a representation concentration gradient of each pixel and representation concentration-gradient intensity to which the aforementioned model data correspond Have up a representation concentration-gradient evaluation value calculation means to calculate the value which evaluates the difference of the direction of a representation concentration gradient, and representation concentration-gradient intensity, and a means to compute the degree of similar by adding this evaluation value, and it is.
[0032] Moreover, a direction calculation means of a concentration gradient by which the degree

calculation equipment of similar concerning a claim 20 asks for the direction of a concentration gradient in each pixel of two or more pictures beforehand, A concentration-gradient on-the-strength calculation means to compute the concentration-gradient intensity in each pixel of the aforementioned two or more pictures, A direction calculation means of a representation concentration gradient this to compute the direction of a representation concentration gradient from a concentration gradient, A representation concentration-gradient on-the-strength calculation means to compute representation concentration-gradient intensity from the aforementioned concentration-gradient intensity, The storage section which creates and memorizes ******** model data, the direction of a concentration gradient of an input picture, and concentration-gradient intensity between the directions of a representation concentration gradient of each pixel and representation concentration-gradient intensity to which the aforementioned model data correspond It has a representation concentration-gradient evaluation value calculation means to calculate the value which evaluates the difference of the direction of a representation concentration gradient, and representation concentration-gradient intensity, an addition means to add this evaluation value, and a division means to compute the degree of similar by carrying out the division of this with the number of pixels.

[0033] Moreover, the degree calculation equipment of similar concerning a claim 21, a claim 22, a claim 23, and a claim 24 all has the respectively same feature as a claim 15, a claim 16, a claim 17, and a claim 18 in the thing of a claim 19 or a claim 20.

[0034] The degree of similar of two shade pictures is computed by adding the value which evaluated the difference of the direction of a concentration gradient by the degree calculation equipment of similar concerning a claim 1 or a claim 6. The direction of a concentration gradient has the feature that a value is the same, when the contrast which consists of a background and the object section changes. Moreover, if it sees locally when the amount of background changes continuously since the direction of a concentration gradient is computed using a mask operation, the amount of background will be the same concentration. For this reason, there is the feature that the direction of a concentration gradient cannot change easily. Moreover, although the direction of a concentration gradient becomes amusing in the discontinuous portion of background change when the object is drawn on the complicated background, since the direction of a concentration gradient is computed locally, there is the feature of not spreading in the whole picture. Therefore, as for a portion discontinuous to a background, in a pattern with few the rate of a certain thing, a mark and recognition of a character are attained like a pattern from which the gray level of a background changes continuously like shading, and a complicated background.

[0035] With the degree calculation equipment of similar concerning a claim 1, a claim 2, a claim 7, and a claim 8, since a division is carried out with the number of pixels, or weight total value, when the number of pixels and weight total value change, the meaning of the degree of similar does not change, but a threshold arrangement becomes easy. By the degree calculation equipment of similar and the method concerning a claim 3 and a claim 9, since it is considering as the correlation value which carried out weighting by concentration-gradient intensity, a mark and recognition of a character are attained also in a pattern from which a background differs by the picture like a complicated background.

[0036] Since the value which evaluated the difference of the direction of a concentration gradient is made into three values of 1, 0, and -1, the effect that the amount of operations is cut down is obtained with the degree calculation equipment of similar and the method concerning a claim 5 and a claim 11. By the degree calculation equipment of similar and the method of a claim 5 and a claim 11 Maximum of a value which evaluated the difference of the direction of a concentration gradient is set to 1, and the minimum value is set to -1. by the degree calculation equipment of similar and the method of a claim 2 and a claim 8 Since a division is carried out with the number of pixels, or weight total value, when the number of pixels and weight total value change, the degree maximum of similar is set to 1, the minimum value is set to -1, and the degree of similar of a model picture and the same input picture is set to 1. Therefore, since two or more models with one threshold can be recognized, a threshold setup becomes easy.

[0037] Since the value which evaluated the difference of the direction of a concentration gradient by the degree calculation equipment of similar and the method of a claim 4 and a claim 10 is made into the

cosine of the difference of the direction of a concentration gradient, the degree of similar of a model picture and the input picture displayed in white is set to -1. With the degree detection equipment of similar of a claim 15, a claim 16, a claim 17, a claim 18, a claim 19, a claim 20, a claim 21, a claim 22, a claim 23, and a claim 24, since the direction of a representation concentration gradient and representation concentration-gradient intensity are computed and it asks for the degree of similar, even when the work with which the mark, the character, etc. were clearly drawn on solid color cannot be prepared, it is possible unstated.

[0038]

[Embodiments of the Invention] Hereafter, the gestalt of operation explains this invention to a detail further. Drawing 1 is the block diagram showing the composition of the image processing system of the gestalt 1 of operation of this invention. The gestalt equipment of this operation is equipped with the same camera 1 as the conventional image processing system shown in drawing 23 , A/D converter 2, an image memory 3, D/A converter 4, CRT display 5, the address/data bus 6, the timing-control section 7, CPU8, memory 9, and the threshold judging section 11, and also was replaced with the degree calculation section 10 of similar, and is equipped with the direction calculation section 16 of a concentration gradient, the concentration-gradient on-the-strength calculation section 17, and the degree calculation section 18 of similar.

[0039] The above-mentioned degree calculation section 18 of similar is equipped with the weight sum calculation section 19, the subtraction section 20, the direction difference evaluation section 21, the sum-of-products operation part 22, and the division section 23 as shown in drawing 2 . In the gestalt image processing system of this operation, the analog video signal outputted from the camera 1 is A/D converter 2, and after A/D conversion is carried out synchronizing with the timing signal from the timing-control section 7, it is memorized by the image memory 3. After the picture [(a) of drawing 4] incorporated by the image memory is changed into an analog signal through D/A converter 4, it is displayed on CRT display 5. On the other hand, the picture incorporated by the image memory 3 is changed in the direction of an input concentration gradient [(b) of drawing 4] in the direction calculation section 16 of a concentration gradient, and is memorized by memory 9. In the degree calculation section 18 of similar, in the concentration-gradient on-the-strength calculation section 17 and the direction calculation section 16 of a concentration gradient, it is computed beforehand, and the degree of similar is computed using the model concentration-gradient intensity [(b) of drawing 3] memorized by memory 9, and (c) and the direction of an input concentration gradient [drawing 4 (b)] of direction of model concentration gradient [drawing 3 . The computed degree of similar is memorized by memory 9. Comparison with the degree of similar memorized by memory 9 and the threshold set up beforehand is performed in the threshold judging section 11, and the judgment of OK/NG is carried out. The result is memorized by memory 9. Delivery of the data between each module is performed through the address / data bus 6. Moreover, invocation command issue of each module is performed by CPU8.

[0040] In the degree calculation section of similar, if the size of the direction of a model concentration gradient, model concentration-gradient intensity, and the direction of an input concentration gradient is set to (mx, my) and MW (x y) and the direction of an input concentration gradient are set [the direction of a model concentration gradient] to Itheta (x y) for Mtheta (x y) and model concentration-gradient intensity, the degree of similar (R) will be computed by the following formulas.

[0041]

[Equation 9]

$$R = \frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{M_W(x, y)\cdot f(I_\theta(x, y)-M_\theta(x, y))\}}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}M_W(x, y)}$$

[0042] here -- the evaluation value of the difference value of direction of input concentration gradient

Itheta (x y), and direction of model concentration gradient Mtheta (x y) -- the cosine of the difference of the direction of a concentration gradient -- then (claim 6) --
If the difference of the direction of a concentration gradient is within the limits to **45 degrees containing 0 degree as an evaluated value as an f(omega) =cosomega example, it will be referred to as 1, and in ** (45 degrees - 135 degrees), it is made into 0, and, in ** (135 degrees - 180 degrees), is made into -1 (claim 7).
[0043]
[Equation 10]

$$f(\omega) = \begin{cases} 1 & \{(-45+360n)^\circ \leqq \omega \leqq (45+360n)^\circ\} \\ -1 & \{(135+360n)^\circ \leqq \omega \leqq (225+360n)^\circ\} \\ 0 & \{\text{otherwise}\} \end{cases} \quad (n \text{は整数})$$

[0044] It becomes. MW (x y) and direction of model concentration gradient Mtheta (x y) are incorporated through the address / data bus 6 by the degree calculation section 18 of similar in the model concentration-gradient intensity memorized by Itheta (x y) and memory 9 in the direction of an input concentration gradient memorized by the image memory 3. It sets in the weight sum calculation section 19, and is the total value [0045] of model concentration-gradient intensity.
[Equation 11]

$$\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} M_w(x, y)$$

[0046] It ******. Moreover, it sets in the subtraction section 20 and is the difference [0047] of direction of input concentration gradient Itheta (x y) of each pixel, and direction of model concentration gradient Mtheta (x y).
[Equation 12]

$$I_\theta(x, y) - M_\theta(x, y)$$

[0048] It ******. It sets in the direction difference evaluation section 21, and is [0049].
[Equation 13]

$$f(I_\theta(x, y) - M_\theta(x, y))$$

[0050] It ******, it sets to the sum-of-products operation part 22, and is [0051].
[Equation 14]

$$\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{M_w(x, y) \cdot f(I_\theta(x, y) - M_\theta(x, y))\}$$

[0052] It ****** and the degree of similar concerning this operation gestalt is computed in the division section 23. A model is beforehand created in the following procedures and is memorized by memory 9. From a camera 1, a model picture is incorporated to an image memory 3 through A/D converter 2 [(a) of drawing 3]. A model picture is changed in the direction of a model concentration gradient [(c) of drawing 3] in the direction calculation section 16 of a concentration gradient, and is changed into model concentration-gradient intensity [(b) of drawing 3] in the concentration-gradient on-the-strength calculation section 17. The direction of a model concentration gradient and model concentration-gradient intensity are memorized by memory 9. Concentration-gradient intensity is computed by the following formulas (Sobel operator) in the concentration-gradient on-the-strength calculation section 17.

[0053]
[Equation 15]

$$M_w(x, y) = \sqrt{D_x(x, y)^2 + D_y(x, y)^2}$$

ここで、

$$D_x(x, y) = M(x+1, y-1) + 2M(x+1, y) + M(x+1, y+1) - M(x-1, y-1) - 2M(x-1, y) - M(x-1, y+1)$$

$$D_y(x, y) = M(x+1, y+1) + 2M(x, y+1) + M(x-1, y+1) - M(x+1, y-1) - 2M(x, y-1) - M(x-1, y-1)$$

[0054] As the concentration-gradient on-the-strength calculation method, operators, such as a gradient, are sufficient. In the direction calculation section 16 of a concentration gradient, the direction of a concentration gradient [0 degree, 360 degrees] is computed by the following formulas (Sobel operator).
Mtheta(x y) =atan2 (Dx, Dy)
Here, atan2 puts the arc tangent function of the Dx-Dy coordinate expressed with Dx coordinate and Dy coordinate (drawing 5). As the direction calculation method of a concentration gradient, other operators, such as a Prewitt operator, are sufficient.
[0055] The technique concerning this invention is applied about the pattern of drawing 25 which a normalization cross-correlation makes weak. However, since the mask operation of 3x3 is performed, as shown in (a) of drawing 6 , and (b), a model picture and an input picture shall have a 1-pixel margin in calculation of concentration-gradient intensity and the direction of a concentration gradient. If the direction of a model concentration gradient and the direction of an input concentration gradient are computed using the above-mentioned technique, it will become as shown in (c) of drawing 6 , and (d). Moreover, if model concentration-gradient intensity is computed using the above-mentioned technique, it will become as shown in (e) of drawing 6 . Here, since Dx and Dy were 0, as for a label called ND currently attached in the direction of a model concentration gradient, they show the pixel which becomes unfixed [a direction]. Direction difference evaluation of this pixel is set to f(omega) = 0. The difference of the direction of an input concentration gradient and the direction of a model concentration gradient is shown in (f) of drawing 6 . If a direction difference is evaluated using f(omega) =cosomega and the above-mentioned numerical example, it will become like (g) of drawing 7 , and (h), and a value will become small in a portion with the discontinuous concentration value of a background except for a portion (ND) with an unfixed direction. However, in except [it], it turns out that the evaluation value is 1 closely, without being influenced by the contrast of a background and the character section. Even if the degree of similar when f (omega) concerning about 0.92 and a claim 7 is used for the degree of similar at the time of using f (omega) concerning a claim 6 is set to about 0.94 and it measures it against the degree of similar using the normalization cross-correlation (about 0.61), it turns out that there is no fall of an evaluation value, and it is understood that the degree of similar computing method concerning this invention is strong to background change.
[0056] In addition, also in the pattern (drawing 8) which has shading in a background, when f (omega) which starts about 0.98 and a claim 7 when f (omega) concerning a claim 6 is used in the degree of similar computing method concerning this invention to the degree of similar by the normalization cross-correlation being about 0.91 was used, it was set to 1.0, and it was shown that this technique is effective also to shading.
[0057] Drawing 9 is the block diagram showing the position detection equipment of the operation gestalt 2 of this invention. This operation gestalt position detection equipment is equipped with the composition section of the same number of the image processing system shown in drawing 1 , and also was further replaced with the degree calculation section 18 of similar, and the threshold judging section 11, and is equipped with the collating position detecting element 24, the weight sum calculation section 25, the degree calculation section 26 of similar, and the position detecting element 27.
[0058] The degree calculation section 26 of similar is equipped with the subtraction section 20, the direction difference evaluation section 21, the sum-of-products operation part 22, and the division section 23 as shown in drawing 10 . In addition, the weight sum computed in the weight sum calculation section 25 is added to the division section 23 through the address / data bus 6.
[0059] With this operation gestalt position detection equipment, the analog video signal outputted from

the camera 1 is A/D converter 2, and after A/D conversion is carried out synchronizing with the timing signal from the timing-control section 7, it is memorized by the image memory 3. After the picture [drawing 12 (a)] incorporated by the image memory 3 is changed into an analog signal through D/A converter 4, it is displayed on CRT display 5. On the other hand, in the direction calculation section 16 of a concentration gradient, the picture incorporated by the image memory 3 is changed in the direction of an input concentration gradient [(b) of drawing 12], and is memorized by memory 9. In the collating position calculation section 24, the collating position (i, j) (upper left corner coordinate criteria of a model) of a model and an input picture is calculated. The model concentration-gradient intensity which is beforehand computed in the concentration-gradient on-the-strength calculation section 17 and the direction calculation section 16 of a concentration gradient, and is memorized by memory 9 in the degree calculation section 26 of similar [(b) of drawing 11], It is computed in the direction of a model concentration gradient [(c) of drawing 11], and the weight sum calculation section 25, and the degree of similar [R (i, j)] is computed using the total value of the model concentration-gradient intensity memorized by memory 9. The computed degree of similar and its collating position are memorized by memory 9. The value set in the collating position calculation section 24 (i, j) is changed one by one, and the degree of similar in all possible collating positions is computed. In addition, in the collating position calculation section 24, when the message of a search end comes on the contrary, processing is moved to the position detecting element 27. Comparison with the maximum of the degree of similar memorized by memory 9 and the threshold set up beforehand is performed by the position detecting element 27, and the judgment of OK/NG is carried out. The result is memorized by memory 9. Moreover, in O.K., the position of maximum, i.e., the collating position of a model and an input picture, (imax, jmax) is memorized by memory 9. Delivery of the data between each module is performed through the address / data bus 6. Moreover, invocation command issue of each module is performed by CPU8.

[0060] The flow of processing of the collating position calculation section is shown in drawing 14 . The search range (drawing 13) defined beforehand is made into (sx, sy)- (ex, ey). = (sx-1, sy) shall be set up as initial value (i, j). A model is scanned toward the lower right from the upper left of the search range so that a model may be settled in the search range, and it asks for the collating position of a model and an input picture. If collating ends to a lower right corner, a position detecting element will return the judgment of a search end.

[0061] In the degree calculation section of similar, the degree R of similar (i, j) in a collating position (i, j) is computed by the following formulas.

[0062]

[Equation 16]

$$R(i,j)=\frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{M_w(x,y)\cdot f(I_\theta(i+x,j+y)-M_\theta(x,y))\}}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}M_w(x,y)}$$

[0063] In addition, about a calculation procedure, it is the same as that of the operation gestalt 1. Moreover, also in this operation gestalt, the effect that it can recognize stably is obtained to background change or shading like the operation gestalt 1. Drawing 15 is the block diagram showing the composition of the stamp character reader of the operation gestalt 3 of this invention. This example stamp character reader of basic composition is almost the same as that of the position detection equipment of drawing 9 , and has the composition section of the same number as the position detection equipment of drawing 9 , and also it replaced with the position detecting element 27 further, and has the character reading section 28.

[0064] In this operation form stamp character reader, the analog video signal outputted from the camera 1 is A/D converter 2, and after A/D conversion is carried out synchronizing with the timing signal from timing control 7, it is memorized by the image memory 3. After the picture [(a) of drawing 17]

incorporated by the image memory 3 is changed into an analog signal through D/A converter 4, it is displayed on CRT display 5. On the other hand, the picture incorporated by the image memory 3 is changed in the direction of an input concentration gradient [(b) of drawing 17] in the direction calculation section 16 of a concentration gradient, and is memorized by memory 9. In the collating position calculation section 24, the collating position (i, j) (upper left corner coordinate criteria of a model) of a model and an input picture is calculated.

[0065] The concentration-gradient on-the-strength calculation section 17 is attained to, and in the direction calculation section 16 of a concentration gradient, the direction of a model concentration gradient [(c) of drawing 16] is beforehand computed by each character [(a)] of every, and is remembered to be model concentration-gradient intensity [(b) of drawing 16] by memory 9. [of drawing 16] Moreover, for every character, the total value of model concentration-gradient intensity is computed in the weight sum calculation section 25, and is memorized by memory 9. In the degree calculation section 26 of similar, the degree of similar [R (i, j.model)] is computed using the total value of model concentration-gradient intensity [(b) of drawing 16], the direction of a model concentration gradient [(c) of drawing 16], and model concentration-gradient intensity. The computed degree of similar [R (i, j.model)], and the collating position (i, j) and a model name (model) are memorized by memory 9. A value [one by one / (i, j)] is changed, and the degree of similar in all possible collating positions is computed. This is performed about all the characters that read.

[0066] In the character reading section 28, reading of a character is performed using the degree of similar memorized by memory 9. all in some collating positions (i, j) -- the model in which the maximum is shown among the degrees of similar to a model is made into model-max The degree R of similar (i, j, model-max) is set up beforehand, in more than the threshold memorized by memory 9, if the character corresponding to a model (model-max) is in the position of (i, j) is judged, and a character and a position are memorized in memory 9. This is performed about all being possible (i, j).

[0067] Delivery of the data between each module (composition section) is performed through the address / data bus 6. Moreover, invocation command issue of each module is performed by CPU8. Processing of the collating position calculation section is the same as that of the operation form 2. In the degree calculation section of similar, the degree of similar (i, j.model) in the collating position (i, j) of a certain model (model) is computed by the following formulas.

[0068]

[Equation 17]

$$R(i,j,model)=\frac{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}\{M_{w,model}(x,y)\cdot f(I_{\theta}(i+x,j+y)-M_{\theta,model}(x,y))\}}{\sum_{x=0}^{mx-1}\sum_{y=0}^{my-1}M_{w,model}(x,y)}$$

[0069] In addition, about a calculation procedure, it is the same as that of the operation form 1. In the case of a stamp character [(a) of drawing 18], when the direction of a concentration gradient is seen, 180 degrees of directions may shift by the direction of lighting also in the same position [(f) of drawing 19 , (g)]. Since the position of a shadow changes with how depending on which lighting hits, this is for how [(b) of drawing 18 , (c)], and a picture are in sight to change [(d) of drawing 18 , (e)]. When f (omega) =cos (2omega), then 180 degrees of directions shift, it is set to f(omega) = 1, and since it corresponds to this, the function f of the formula of the degree of similar (omega) can be dealt with so that similarly [a direction]. That is, it is f(theta) =f (theta+180).

[0070] For example, when asking for the degree of similar with the picture [(d) of drawing 21] from which the direction of lighting differs using the model picture of (a) of drawing 20 , the angle difference of the direction of a model concentration gradient [(c) of drawing 21] and the direction of an input concentration gradient [(e) of drawing 21] becomes 180 degrees by the direction of lighting [(f) of drawing 22]. Therefore, the value of f (omega) is set to 1.0 by setting f (omega) of the formula of the degree of similar to f(omega) =cos (2omega) [(h) of drawing 22]. Therefore, when the degree of similar

is calculated, it is set to 1.0 and there is no fall of the degree of similar. On the other hand, though it was set to -0.84 and the absolute value was taken when asked for the degree of similar of a model picture [(a) of drawing 20], and an input picture [(d) of drawing 21] using the conventional technique, it was set to 0.84, and the predominance of the technique concerning this invention was shown.

[0071] With each equipment, such as the degree detection equipment of similar of the operation form shown by above-mentioned drawing 1 - drawing 25 , on solid color, objects, such as a mark and a character, picturized the work drawn clearly, and have registered the direction of a concentration gradient and concentration-gradient intensity in each pixel position as a model. However, the work with which the mark now printed on the transparent sheet like drawing 26 as an example here may lap with various positions on a background pattern is considered. It is the pictures 0-4 of drawing 27 which picturized these works. As for the picture 0, the mark has lapped on solid color. The direction of a concentration gradient and concentration-gradient intensity of each picture become like drawing 28 and drawing 29 . The part smeared away black in drawing 28 and the direction of a concentration gradient of drawing 29 means that a direction is unfixed.

[0072] It is the formula of the degree calculation of similar [0073]

[Equation 18]

$$R = \frac{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} \{ M_w(x, y) \cdot f(I\theta(x, y) - M\theta(x, y)) \}}{\sum_{x=0}^{mx-1} \sum_{y=0}^{my-1} M_w(x, y)}$$

[0074] It carries out. The size of the direction of a model concentration gradient, model concentration-gradient intensity, and the direction of an input concentration gradient was made into mxxmy here, and Mw (x y) and the direction of an input concentration gradient were set [the direction of a model concentration gradient] to Itheta (x y) for Mtheta (x y) and model concentration-gradient intensity. It is the function f by which a direction difference is evaluated [0075]

[Equation 19]

$$f(\omega) = \begin{cases} 1 & \{(-45+360n)^\circ < \omega < (45+360n)^\circ\} \\ -1 & \{(135+360n)^\circ < \omega < (225+360n)^\circ\} \\ 0 & \{(otherwise)\ (n\text{は整数})\} \end{cases}$$

[0076] It carries out. When a model is made from the work with which the mark lapped on solid color like a picture 0, a work of the correlation value R with which a mark laps on a background pattern like a picture 1 in an input is also about 0.93. This can perform quite near and stable recognition in comparison with the correlation value 1.0 of model pictures.

[0077] However, when the work with which the object was drawn on solid color cannot be prepared and it is going to collate using the model created from the work with which the object was drawn on a background pattern, there is a trouble that the degree of similar serves as a small value compared with the conventional model, and the precision of recognition becomes bad. For example, if a model is made from a picture 4, the degree of similar with a picture 1 becomes small with 0.74, and stable recognition cannot be performed.

[0078] Since there are the above troubles, when the work with which the object was drawn on solid color cannot be prepared, it turns out that sufficient performance is not obtained. Below, even if it cannot prepare the work with which the object was drawn on solid color by having a means to create one model from the picture which picturized two or more works, the degree calculation equipment of operation form similar with which sufficient performance is obtained is explained.

[0079] Drawing 30 is the block diagram of the degree calculation equipment of similar of the operation form 4 of this invention. Moreover, the block diagram of the position detection equipment of the operation form 5 is shown in drawing 31 . In drawing 30 , drawing 31 adds the direction calculation section 29 of a representation concentration gradient, and the representation concentration-gradient on-

the-strength calculation section 30 to the degree calculation equipment of similar of drawing 1 at the position detection equipment of drawing 9 . Process until the direction calculation section 29 of a representation concentration gradient and the representation concentration-gradient on-the-strength calculation section 30 acquire information required for calculation of the direction of a representation concentration gradient and representation concentration-gradient intensity below is explained.

[0080] The picture of the work with which the object was drawn is picturized by various background patterns in a camera 1. The outputted analog video signal is A/D converter 2, and after A/D conversion is carried out synchronizing with the timing signal from the timing-control section 7, it is memorized by the image memory 3. The model picture of size mxxmy is memorized by N sheets and the image memory 3 with the aforementioned procedure. In the direction calculation section 16 of a concentration gradient, the concentration-gradient intensity Mw (ix, y) is computed for direction of concentration gradient Mtheta (ix, y) in the position (x y) (0<=x<= (mx-1), 0<=y<= (my-1)) of the picture i (1 <=i<=N) memorized by the image memory 3 in the concentration-gradient on-the-strength calculation section 17. Direction of concentration gradient Mtheta (ix, y) and the concentration-gradient intensity Mw (ix, y) are memorized by memory 9. The direction Mthetap (x y) of a representation concentration gradient of a position (x y) is computed in the direction calculation section 29 of a representation concentration gradient based on Mtheta (ix, y). moreover, the representation concentration-gradient intensity Mwp (x y) of a position (x y) -- M -- based on theta (ix, y) and Mw (ix, y), it is computed in the representation concentration-gradient on-the-strength calculation section 30

[0081] Drawing 32 is the flow view showing performing calculation of the direction of a representation concentration gradient, and representation concentration-gradient intensity in all the positions in a model picture (x y) (0<=x<= (my-1), 0<=y<= (my-1)). First, while performing processing (flow drawing 33 - 36) which sets Variable x and y to 0 (ST11), next asks for the direction of a representation concentration gradient and representation concentration-gradient intensity in each position (ST12) and incrementing Variable x one time (ST13), processing of ST12 and ST13 is repeated until this variable reaches mx. The judgment of ST14 serves as NO, when it comes to x=mx, y is shortly made into one increment, x is set to 0 (ST16), and it returns to ST12, and again, processing of ST12 and ST13 is repeated until it becomes x=mx. When it comes to x=mx, Variable y is incremented one time again. And processing of the above ST11-ST16 is repeated until it becomes y=my -1.

[0082] The flow view of the direction calculation section 29 of a representation concentration gradient concerning a claim 16 is shown in drawing 33 . Here, first, 0 and Variable beta are set to 0, Variable i is set to 1, initial setting of the variable alpha is carried out (ST21), and, next, the direction indeterminate of Mtheta(ix, y) != or ? is judged (ST22). If not unfixed, the operation of alpha=alpha+cosMtheta (ix, y) and beta=beta+sinM theta (ix, y) will be performed (ST23). Next, processing of ST22-ST24 is repeated until it increments Variable i one time (ST24) and Variable i exceeds N (ST25). If the judgment of ST25 serves as YES, the operation of alpha=alpha/N and beta=beta/N will be performed (ST26). In the value of alpha, in a step ST 26, the average of the cosine of direction of concentration gradient Mtheta (ix, y) and the value of beta serve as an average of the sine of direction of concentration gradient Mtheta (ix, y). Namely, [0083]

[Equation 20]

$$\alpha = \frac{1}{N} \sum_{i=1}^{N} \cos M\theta(i, x, y), \quad \beta = \frac{1}{N} \sum_{i=1}^{N} \sin M\theta(i, x, y)$$

[0084] When the value of direction of concentration gradient Mtheta (ix, y) is unfixed, the judgment is performed in ST22, ST23 is skipped and addition by ST23 is not performed. Since the value becomes small so that the square root of (alpha2+beta2) has large dispersion between direction of concentration gradient Mtheta (ix, y), it becomes the index of the stability of direction of concentration gradient Mtheta (ix, y) in an attention pixel (x y). It is based on the value of alpha and beta and the direction Mthetap (x y) of a representation concentration gradient is [0085].

[Equation 21]

$$M\theta_p(x, y) = \begin{cases} \text{方向不定} \ (\sqrt{\alpha^2+\beta^2} < \delta \text{ のとき}) \\ \text{atan2}(\alpha, \beta) \ (\text{otherwise}) \end{cases}$$

[0086] It becomes. delta is the threshold set up beforehand here. In atan2 (X, Y), the arc tangent function of the X-Y coordinate expressed with an X coordinate and a Y coordinate is put (drawing 5). The flow view of the representation concentration-gradient on-the-strength calculation section 30 concerning a claim 17 is shown in drawing 34 . Here, processing of ST32 and ST33 is repeated until set a variable M1 to 0, set Variable i to 1 first (ST31), and it calculates M1=M1+MW (ix, y), although representation concentration-gradient intensity is computed (ST32), and it increments Variable i to it one time further (ST33) and Variable i is set to N to it. And if it becomes i=N by ST34, representation concentration-gradient on-the-strength MWP1(x y): (MWP1(x y) =M1/N) will be computed. The representation concentration-gradient intensity Mwp1 (x y) is the arithmetical mean of the concentration-gradient intensity Mw (ix, y), and [0087].

[Equation 22]

$$M_{wp1}(x, y) = \frac{1}{N} \sum_{i=1}^{N} M_w(i, x, y)$$

[0088] It becomes. The flow view of the representation concentration-gradient on-the-strength calculation section 30 concerning a claim 18 is shown in drawing 35 . When judged with NO in a step ST 46, for a size, the concentration-gradient intensity Mw (ix, y) and the sense are [the value of M2 / a size / 1 and the sense / the vector of the direction Mthetap (x y) of a representation concentration gradient and] the inner product sum with the vector of direction of concentration gradient Mtheta (ix, y), and [0089].

[Equation 23]

$$M_2 = \sum_{i=1}^{N} [M_w(i, x, y) \times \{\cos M\theta(i, x, y) \times \cos M\theta_p(x, y) + \sin M\theta(i, x, y) \times \sin M\theta_p(x, y)\}]$$

[0090] It becomes. It is skipped without performing the judgment in a step ST 42 and performing processing of Steps ST43 and ST44, when the value of direction of concentration gradient Mtheta (ix, y) is unfixed, and it moves to ST45. The representation concentration-gradient intensity Mwp2 (x y) is the quotient of M2 and N, and [0091].

[Equation 24]

$$M_{wp2}(x, y) = M_2 \div N$$

[0092] It becomes (ST47). There is a property in which contribution of the concentration-gradient intensity Mw (ix, y) becomes small in the representation concentration-gradient intensity Mwp2 (x y), so that direction of concentration gradient Mtheta (ix, y) separates [Mthetap (x y)] from a representation concentration gradient. The flow view of the representation concentration-gradient on-the-strength calculation section 30 concerning a claim 19 is shown in drawing 36 . In the value of alpha, in a step ST 58, the average of the cosine of direction of concentration gradient Mtheta (ix, y) and the value of beta serve as an average of the sine of direction of concentration gradient Mtheta (ix, y). Namely, [0093]

[Equation 25]

$$\alpha = \frac{1}{N} \sum_{i=1}^{N} \cos M\theta(i, x, y), \quad \beta = \frac{1}{N} \sum_{i=1}^{N} \sin M\theta(i, x, y)$$

[0094] It becomes. Moreover, for a size, the concentration-gradient intensity Mw (ix, y) and the sense are [the value of M3 / a size / 1 and the sense / the vector of the direction Mthetap (x y) of a

representation concentration gradient and] the average of the inner product sum with the vector of concentration-gradient on-the-strength Mtheta (ix, y), and [0095].
[Equation 26]

$$M_3 = \sum_{i=1}^{N} [M_w(i, x, y) \times \{\cos M\theta(i, x, y) \times \cos M\theta_p(x, y) + \sin M\theta(i, x, y) \times \sin M\theta_p(x, y)\}]$$

[0096] It becomes. When the value of direction of concentration gradient Mtheta (ix, y) is unfixed, the judgment is performed in a step ST 52, and processing of ST53, ST54, and ST55 is not performed. The representation concentration-gradient intensity Mwp3 (x y) becomes the product of the root used as M3 and the index of the stability of direction of concentration gradient Mtheta (ix, y) (alpha2+beta2).
[0097]
[Equation 27]

$$M_{wp3}(x, y) = M_3 \times \sqrt{\alpha^2 + \beta^2}$$

[0098] It becomes. There is a property in which the value becomes small in the representation concentration-gradient intensity Mwp3 (x y), so that direction of concentration gradient Mtheta (ix, y) varies. The aforementioned direction of a representation concentration gradient and aforementioned representation concentration-gradient intensity are computed to below from the pictures 1-4 of drawing 27 , and the degree of similar with a picture 1 is shown in it. In addition, threshold delta in the case of the direction Mthetap (x y) of a representation concentration gradient and calculation of representation concentration-gradient intensity of Mwp3 (x y) was set to 0.
[0099] About pictures 1-4 to the direction Mthetap of a representation concentration gradient (x y) and representation concentration-gradient intensity, if Mwp1 (x y) is calculated, it will become like drawing 37 and drawing 38 . It will be set to about 0.89 if the degree of similar of this model and picture 1 is computed. About pictures 1-4 to the direction Mthetap of a representation concentration gradient (x y) and representation concentration-gradient intensity, if Mwp2 (x y) is calculated, it will become like drawing 39 . It will be set to about 0.89 if the degree of similar of this model and picture 1 is computed.
[0100] About pictures 1-4 to the direction Mthetap of a representation concentration gradient (x y) and representation concentration-gradient intensity, if Mwp3 (x y) is calculated, it will become like drawing 40 . It will be set to about 0.97 if the degree of similar of this model and picture 1 is computed. Since it is close to the degree of similar of a picture 0 and a picture 1 (about 0.93), the stable recognition of any case is attained.
[0101] As mentioned above, a model can be made even when the work with which the mark and the character were drawn on solid color cannot be prepared by the model creation technique concerning this invention.
[0102]
[Effect of the Invention] By adding the value which evaluated the difference of the direction of a concentration gradient, the degree of similar of two pictures is computed, and the direction of a concentration gradient has a value the same according to invention concerning a claim 1, a claim 2, a claim 7, and a claim 8, when the contrast which consists of a background and the object section changes. If it sees locally when the amount of background changes continuously since it is computed using a mask operation, the amount of background is the same concentration, and the direction of a concentration gradient cannot change easily. Although the direction of a concentration gradient becomes amusing in the discontinuous portion of background change when the object is drawn on the complicated background, since the direction of a concentration gradient is computed locally, it does not spread in the whole picture. Since there is the feature of **, a portion discontinuous to a background is effective in a mark and recognition of a character being attained in a pattern with few the rate of a certain thing like a pattern from which the gray level of a background changes continuously like shading, and a complicated background.

[0103] Moreover, according to invention concerning a claim 2, a claim 7, and a claim 8, since a division is carried out with the number of pixels, or weight total value, when the number of pixels and weight total value change, the meaning of the degree of similar does not change, but it is effective in a threshold arrangement becoming easy. Moreover, since it is considering as the correlation value which carried out weighting by concentration-gradient intensity according to invention concerning a claim 3 and a claim 9, also in a pattern from which a background differs by the picture like a complicated background, it is effective in a mark and recognition of a character being attained.
[0104] According to invention concerning a claim 2, a claim 7, and a claim 8, since two or more models with one threshold can be recognized, it is effective in a threshold setup becoming easy. Moreover, according to invention concerning a claim 4 and a claim 10, since the value which evaluated the difference of the direction of a concentration gradient is made into the cosine of the difference of the direction of a concentration gradient, the degree of similar of a model picture and the input picture displayed in white has the effect which is said when it comes to -1.
[0105] Moreover, according to invention concerning a claim 12, the position in the inside of the input picture of a model is detectable with a sufficient precision. Moreover, precision is improved by recognition even when the work with which the mark, the character, etc. were clearly drawn on solid color cannot be prepared according to invention concerning a claim 13 or a claim 24.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the composition of the 1 operation gestalt image processing system of this invention.
[Drawing 2] It is the block diagram showing the composition of the degree calculation section of similar of this operation gestalt image processing system.
[Drawing 3] It is drawing explaining the model picture in this operation gestalt image processing system.
[Drawing 4] It is drawing explaining the input picture in this operation gestalt image processing system.
[Drawing 5] It is drawing explaining the direction calculation of a concentration gradient of the model picture of this operation gestalt image processing system.
[Drawing 6] It is drawing explaining an example of the degree calculation of similar of this operation gestalt image processing system.
[Drawing 7] It is drawing which explains an example of the degree calculation of similar of this operation gestalt image processing system with drawing 6 .
[Drawing 8] It is drawing explaining an example of the degree calculation of similar of this operation gestalt image processing system.
[Drawing 9] It is the block diagram showing the composition of other operation gestalt position detection equipments of this invention.
[Drawing 10] It is the block diagram showing the composition of the degree calculation section of similar of the said operation gestalt position detection equipment.
[Drawing 11] It is drawing explaining the model picture in the said operation gestalt position detection equipment.
[Drawing 12] It is drawing explaining the input picture in the said operation gestalt position detection equipment.
[Drawing 13] It is drawing explaining the position search in the said operation gestalt position detection equipment.
[Drawing 14] It is a flow view explaining the position search processing in the said operation gestalt position detection equipment.
[Drawing 15] It is the block diagram showing the composition of other operation gestalt stamp character readers of this invention.
[Drawing 16] It is drawing explaining the model picture in this operation gestalt stamp character reader.
[Drawing 17] It is drawing explaining the input picture in this operation gestalt stamp character reader.
[Drawing 18] It is drawing explaining a difference of the reading picture by difference of the lighting direction in this operation gestalt stamp character reader.
[Drawing 19] It is drawing which explains a difference of the reading picture by difference of the lighting direction in this operation gestalt stamp character reader with drawing 18 .
[Drawing 20] It is drawing showing an example of stamp alphabetic collating in this operation gestalt stamp character reader.

[Drawing 21] It is drawing in which drawing 20 shows an example of stamp alphabetic collating in this operation gestalt stamp character reader.
[Drawing 22] It is drawing in which drawing 20 and drawing 21 show an example of stamp alphabetic collating in this operation gestalt stamp character reader.
[Drawing 23] It is the block diagram showing the composition of the conventional image processing system.
[Drawing 24] It is the block diagram showing the composition of the degree calculation section of similar of the image processing system of ******.
[Drawing 25] It is drawing showing an example of the model picture of the image processing system of ******, and an input picture.
[Drawing 26] It is drawing showing the case where the work covered by the transparent sheet is installed in what has a background pattern.
[Drawing 27] It is drawing showing the example of the picture which picturized the work shown in drawing 26 .
[Drawing 28] It is drawing showing the direction of a concentration gradient and concentration-gradient intensity of a case of the picture 0 shown in drawing 27 .
[Drawing 29] It is drawing showing the direction of a concentration gradient and concentration-gradient intensity of a case of the picture 1 shown in drawing 27 , a picture 2, a picture 3, and a picture 4.
[Drawing 30] It is the block diagram showing the composition of other degree calculation equipments of operation gestalt similar of this invention.
[Drawing 31] It is the block diagram showing the composition of the operation gestalt position detection equipment of further others of this invention.
[Drawing 32] In the operation gestalt equipment shown in drawing 30 and drawing 31 , it is a flow view in the case of performing calculation of the direction of a representation concentration gradient, and representation concentration-gradient intensity using all the pixels in a model.
[Drawing 33] It is equipment shown in drawing 30 and drawing 31 , and is the flow view showing the calculation method of the direction of a representation concentration gradient.
[Drawing 34] It is equipment shown in drawing 30 and drawing 31 , and is the flow view showing the calculation method of representation concentration-gradient intensity.
[Drawing 35] It is equipment shown in drawing 30 and drawing 31 , and is the flow view showing the another calculation method of representation concentration-gradient intensity.
[Drawing 36] It is equipment shown in drawing 30 and drawing 31 , and is the flow view showing the calculation method of further others of representation concentration-gradient intensity.
[Drawing 37] It is drawing showing the direction of a representation concentration gradient from the picture 1 acquired by the calculation flow view shown in drawing 32 and drawing 33 - a picture 4.
[Drawing 38] It is drawing showing the representation concentration-gradient intensity from the picture 1 acquired by the calculation flow view shown in drawing 32 and drawing 34 - a picture 4.
[Drawing 39] It is drawing showing the representation concentration-gradient intensity from the picture 1 acquired by the calculation flow view shown in drawing 32 and drawing 35 - a picture 4.
[Drawing 40] It is drawing showing the representation concentration-gradient intensity from the picture 1 acquired by the calculation flow view shown in drawing 32 and drawing 36 - a picture 4.
[Description of Notations]
3 Image Memory
9 Memory
19 Weight Sum Calculation Section
20 Subtraction Section
21 Direction Difference Evaluation Section
22 Sum-of-Products Operation Part
23 Division Section

[Translation done.]

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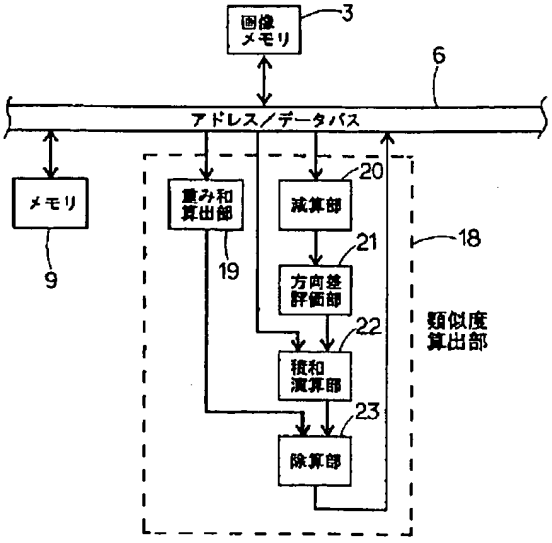
(54)【発明の名称】　類似度算出装置及び方法ならびにこれを用いた位置検出装置

(57)【要約】

【課題】　モデル画像と背景の一部分が変化した入力画像の類似度算出でも、精度よく、結果を出し得る類似度算出装置を提供する。

【解決手段】　画像メモリ３に記憶の入力画像の各画素の濃度勾配方向と、予めメモリ９に記憶のモデルの対応する各画素の濃度勾配方向の差を減算部２０で求め、方向差評価部２１で評価し、モデルより得られる重みで評価値を重み付けて、積和演算部２２で加算し、除算部２３で加算値を重み和算出部１９で算出された重み和で、除算して類似度Ｒを算出する。



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【図２０】同実施形態刻印文字読み取り装置における刻印文字照合の一例を示す図である。

【図２１】図２０ともに、同実施形態刻印文字読み取り装置における刻印文字照合の一例を示す図である。

【図２２】図２０、図２１ともに、同実施形態刻印文字読み取り装置における刻印文字照合の一例を示す図である。

【図２３】従来の画像処理装置の構成を示すブロック図である。

【図２４】同従来の画像処理装置の類似度算出部の構成を示すブロック図である。

【図２５】同従来の画像処理装置のモデル画像と入力画像の一例を示す図である。

【図２６】透明シートに覆われたワークを背景パターンを有するものに設置する場合を示す図である。

【図２７】図２６に示すワークを撮像した画像の例を示す図である。

【図２８】図２７に示す画像０の場合の濃度勾配方向と濃度勾配強度を示す図である。

【図２９】図２７に示す画像１、画像２、画像３及び画像４の場合の濃度勾配方向と濃度勾配強度を示す図である。

【図３０】この発明の他の実施形態類似度算出装置の構成を示すブロック図である。

【図３１】この発明のさらに他の実施形態位置検出装置の構成を示すブロック図である。

【図３２】図３０、図３１に示す実施形態装置において、モデル中の全画素を用いて代表濃度勾配方向と代表濃度勾配強度の算出を行う場合のフロー図である。

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【図３３】図３０、図３１に示す装置で、代表濃度勾配方向の算出方法を示すフロー図である。

【図３４】図３０、図３１に示す装置で、代表濃度勾配強度の算出方法を示すフロー図である。

【図３５】図３０、図３１に示す装置で、代表濃度勾配強度の別の算出方法を示すフロー図である。

【図３６】図３０、図３１に示す装置で、代表濃度勾配強度のさらに他の算出方法を示すフロー図である。

【図３７】図３２、図３３に示す算出フロー図によって得られた画像１～画像４からの代表濃度勾配方向を示す図である。

【図３８】図３２、図３４に示す算出フロー図によって得られた画像１～画像４からの代表濃度勾配強度を示す図である。

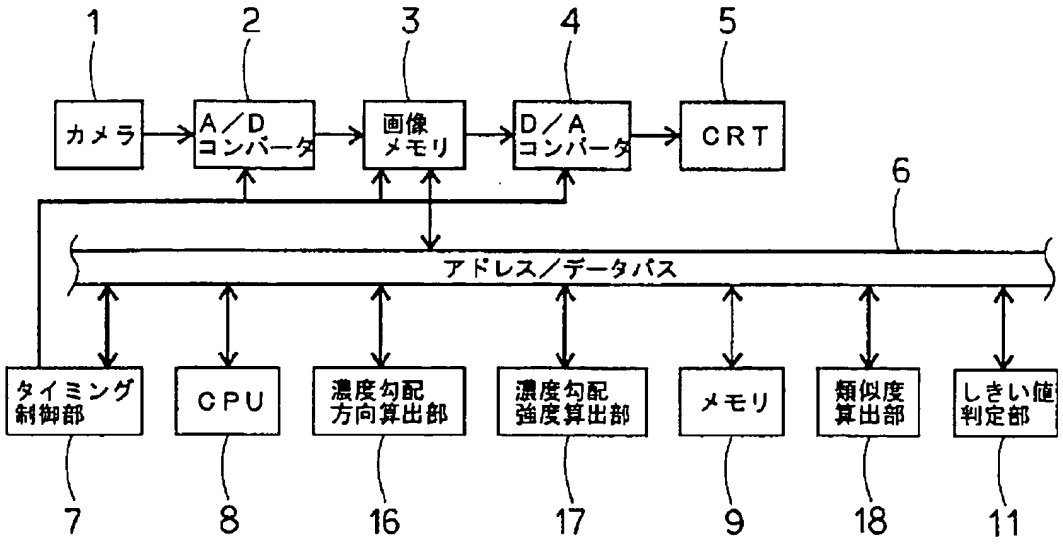
【図３９】図３２、図３５に示す算出フロー図によって得られた画像１～画像４からの代表濃度勾配強度を示す図である。

【図４０】図３２、図３６に示す算出フロー図によって得られた画像１～画像４からの代表濃度勾配強度を示す図である。

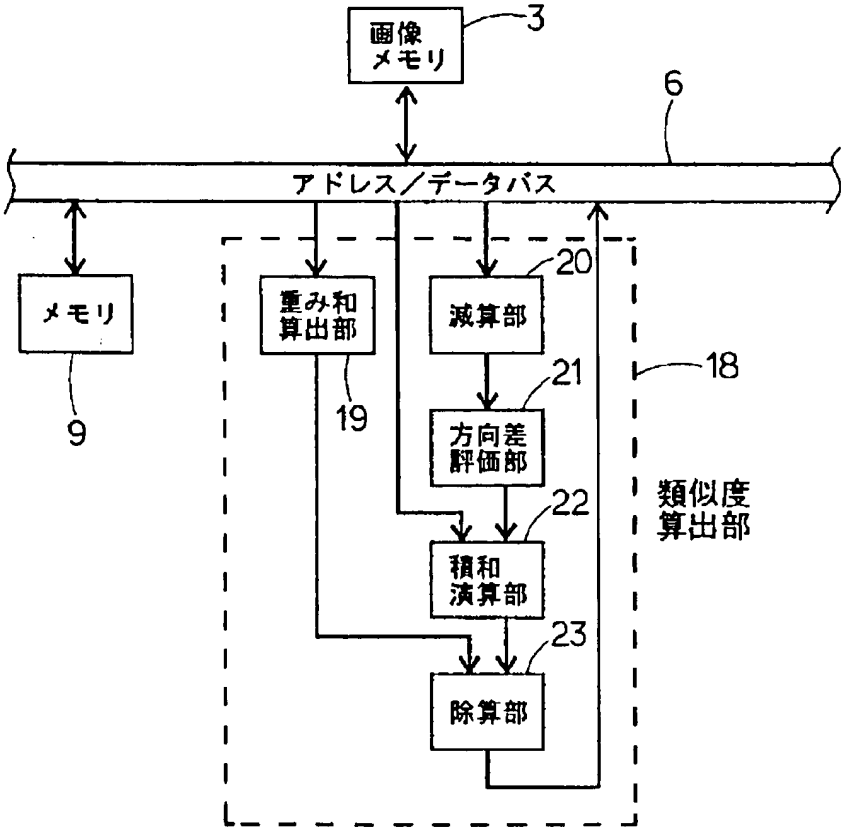
【符号の説明】

３	画像メモリ
９	メモリ
１９	重み和算出部
２０	減算部
２１	方向差評価部
２２	積和演算部
２３	除算部

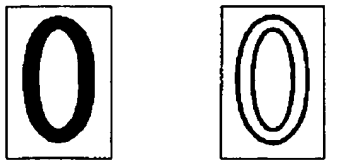
【図１】



【図2】

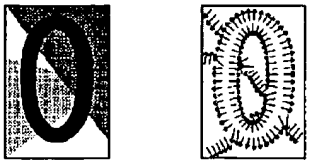


【図3】



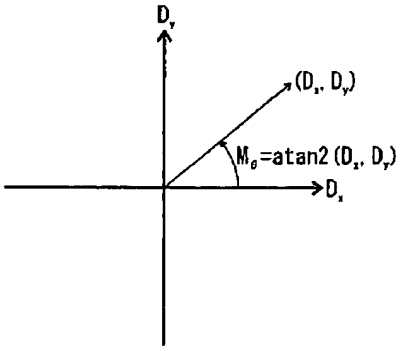
(a)モデル画像　(b)モデル濃度勾配強度　(c)モデル濃度勾配方向

【図4】



(a)入力画像　(b)入力濃度勾配方向

【図5】



【図7】

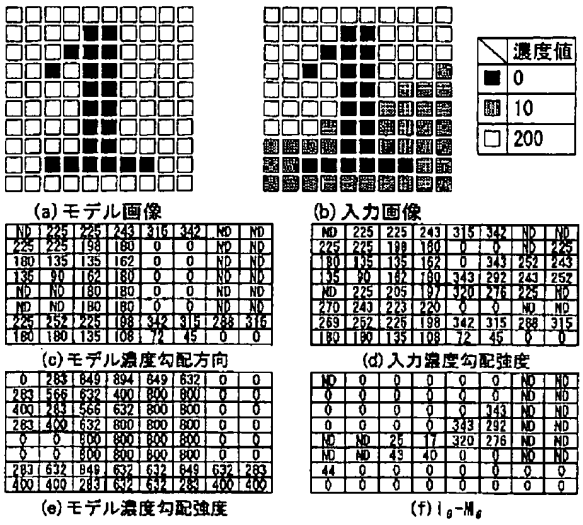
(g) $f(I_\theta-M_\theta)$

0.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	0.96	0.00	0.00
1.00	1.00	1.00	1.00	0.98	0.37	0.00	0.00
0.00	0.00	0.91	0.96	0.77	0.10	0.00	0.00
0.00	0.00	0.73	0.77	1.00	1.00	0.00	0.00
0.72	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(h) $f(I_\theta-M_\theta)$

0.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

【図6】



(a)モデル画像

ND	225	225	243	315	342	ND	ND
225	225	198	180	0	0	ND	ND
180	135	135	162	0	0	ND	ND
135	90	162	180	0	0	ND	ND
ND	ND	180	180	0	0	ND	ND
ND	ND	180	180	0	0	ND	ND
225	252	225	198	342	315	288	315
180	180	135	108	72	45	0	0

(b)入力画像

ND	225	225	243	315	342	ND	ND
225	225	198	180	0	0	ND	225
180	135	135	162	0	343	292	243
135	90	162	180	343	292	243	252
ND	225	205	197	320	276	225	ND
270	243	223	220	6	0	ND	ND
269	252	226	198	342	315	288	315
180	180	135	108	72	45	0	0

(c)モデル濃度勾配方向

0	283	849	894	849	632	0	0
283	566	632	400	800	800	0	0
400	283	566	632	800	800	0	0
283	400	632	800	800	800	0	0
0	0	800	800	800	800	0	0
0	0	800	800	800	800	0	0
283	632	849	632	632	849	632	283
400	400	283	632	632	283	400	400

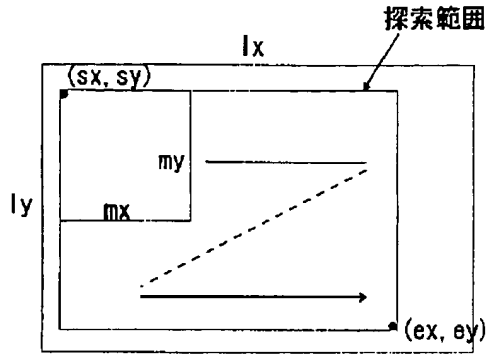
(d)入力濃度勾配強度

ND	0	0	0	0	0	ND	ND
0	0	0	0	0	0	ND	ND
0	0	0	0	0	343	ND	ND
0	0	0	0	343	292	ND	ND
ND	ND	25	17	320	276	ND	ND
ND	ND	43	40	0	0	ND	ND
44	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

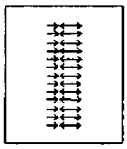
(e)モデル濃度勾配強度

(f) $i_g - M_g$

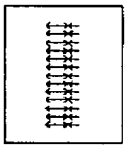
【図13】



【図19】



(f)右方向より照明を当てた場合の濃度勾配方向



(g)左方向より照明を当てた場合の濃度勾配方向

【図8】

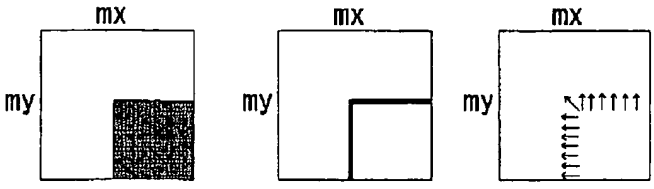
200	200	200	200	200	200	200	200	200	200
200	200	200	200	0	0	200	200	200	200
200	200	200	0	0	0	200	200	200	200
200	200	0	200	0	0	200	200	200	200
200	200	200	200	0	0	200	200	200	200
200	200	200	200	0	0	200	200	200	200
200	200	200	200	0	0	200	200	200	200
200	200	200	200	0	0	200	200	200	200
200	200	0	0	0	0	0	0	200	200
200	200	200	200	200	200	200	200	200	200

(a)モデル画像

40	50	60	70	80	90	100	110	120	130
50	60	70	80	0	0	110	120	130	140
60	70	80	0	0	0	120	130	140	150
70	80	0	100	0	0	130	140	150	160
80	90	100	110	0	0	140	150	160	170
90	100	110	120	0	0	150	160	170	180
100	110	120	130	0	0	160	170	180	190
110	120	130	140	0	0	170	180	190	200
120	130	0	0	0	0	0	0	200	210
130	140	150	160	170	180	190	200	210	220

(b)入力画像

【図11】



(a)モデル画像　(b)モデル濃度勾配強度　(c)モデル濃度勾配方向

【図20】

100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100
100	100	100	200	200	0	0	100	100	100
100	100	100	200	200	0	0	100	100	100
100	100	100	200	200	0	0	100	100	100
100	100	100	200	200	0	0	100	100	100
100	100	100	200	200	0	0	100	100	100
100	100	100	200	200	0	0	100	100	100
100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100

(a)モデル画像

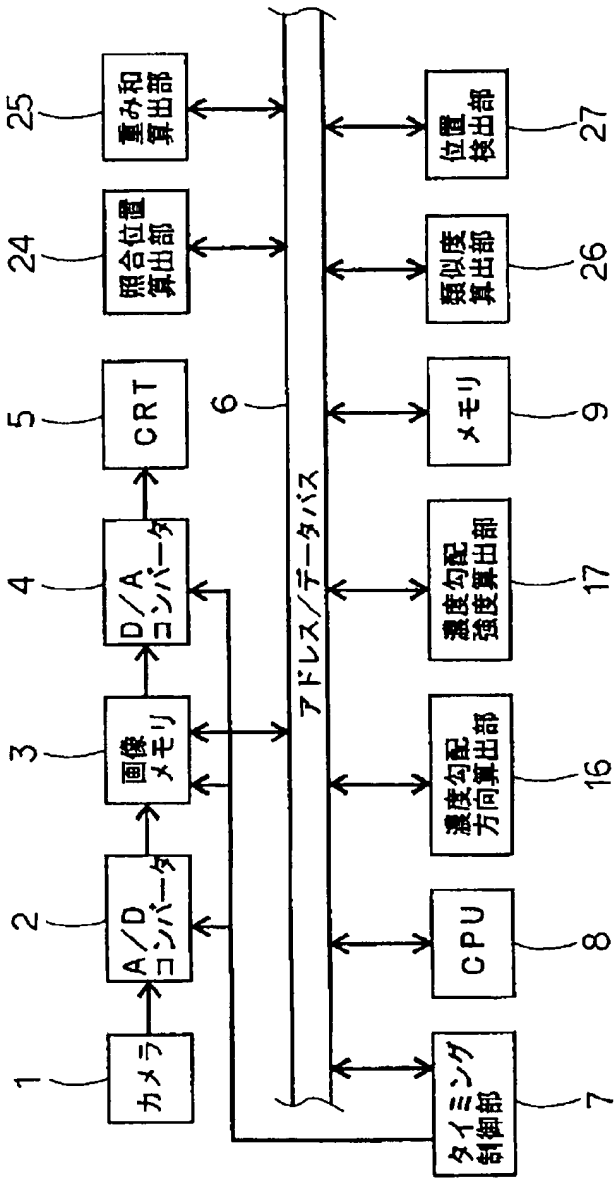
【図16】

(a)モデル画像(文字「3」)　(b)モデル濃度勾配強度　(c)モデル濃度勾配方向

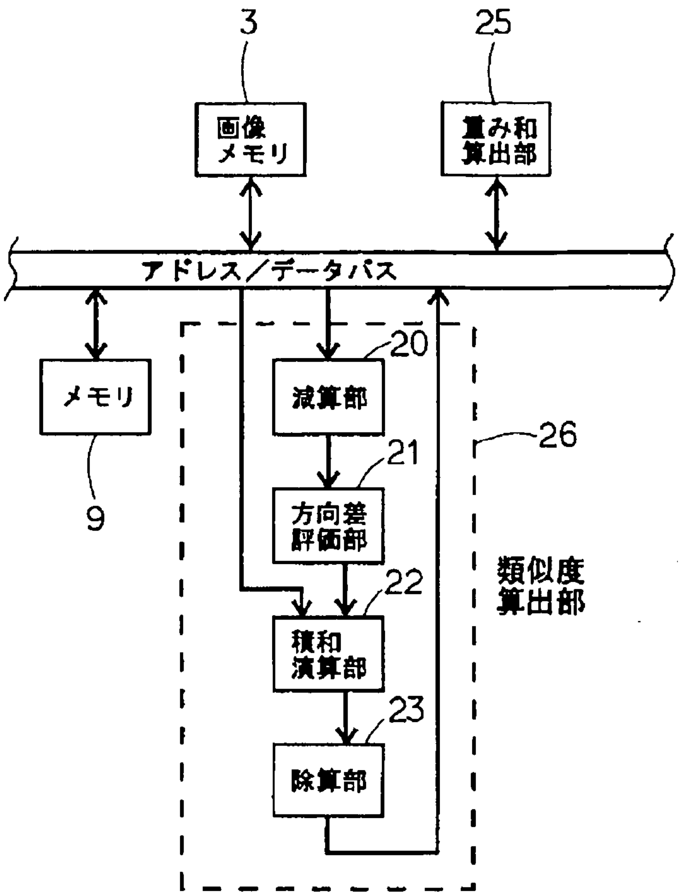
0	0	0	0	0	0	0	0	0	0
0	0	141	316	283	283	316	141	0	0
0	0	316	424	632	632	424	316	0	0
0	0	400	400	800	800	400	400	0	0
0	0	400	400	800	800	400	400	0	0
0	0	400	400	800	800	400	400	0	0
0	0	400	400	800	800	400	400	0	0
0	0	316	424	632	632	424	316	0	0
0	0	141	316	283	283	316	141	0	0
0	0	0	0	0	0	0	0	0	0

(b)モデル濃度勾配強度(Mw)

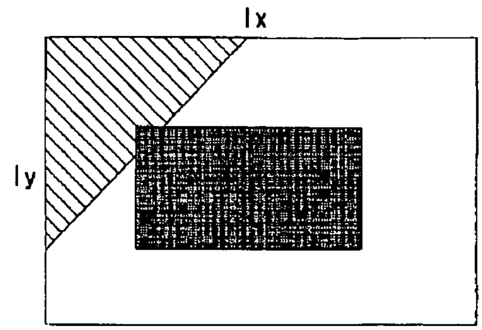
【図9】


1
カメラ
2
A/D コンバータ
3
画像メモリ
4
D/A コンバータ
5
CRT
6
アドレス/データバス
7
タイミング制御部
8
CPU
9
メモリ
16
濃度勾配方向算出部
17
濃度勾配強度算出部
24
照合位置算出部
25
重み和算出部
26
類似度算出部
27
位置検出部

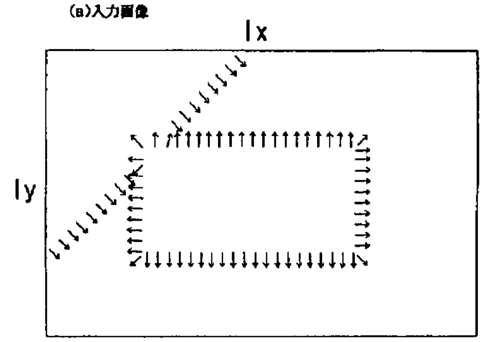
【図10】



【図12】



(a)入力画像



(b)入力濃度勾配方向

【図22】

ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	−180	−180	−180	180	180	180	ND	ND
ND	ND	−180	−180	−180	180	180	180	ND	ND
ND	ND	180	180	−180	−180	180	180	ND	ND
ND	ND	180	180	−180	−180	180	180	ND	ND
ND	ND	180	180	−180	−180	180	180	ND	ND
ND	ND	180	180	−180	−180	180	180	ND	ND
ND	ND	180	180	180	−180	−180	−180	ND	ND
ND	ND	180	180	180	−180	−180	−180	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(f)Iθ－Mθ

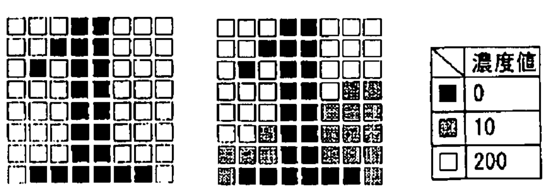
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	−360	−360	−360	360	360	360	ND	ND
ND	ND	−360	−360	−360	360	360	360	ND	ND
ND	ND	360	360	−360	−360	360	360	ND	ND
ND	ND	360	360	−360	−360	360	360	ND	ND
ND	ND	360	360	−360	−360	360	360	ND	ND
ND	ND	360	360	−360	−360	360	360	ND	ND
ND	ND	360	360	360	−360	−360	−360	ND	ND
ND	ND	360	360	360	−360	−360	−360	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(g)2×（Iθ－Mθ）

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

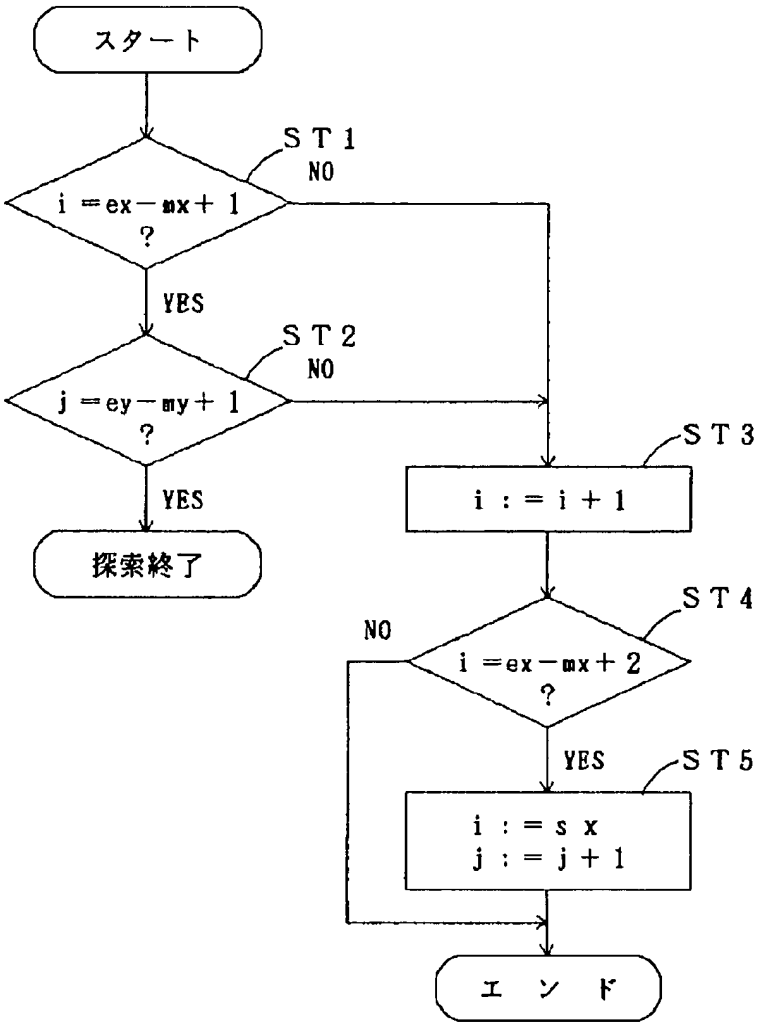
(h)cos(2×（Iθ－Mθ））

【図25】

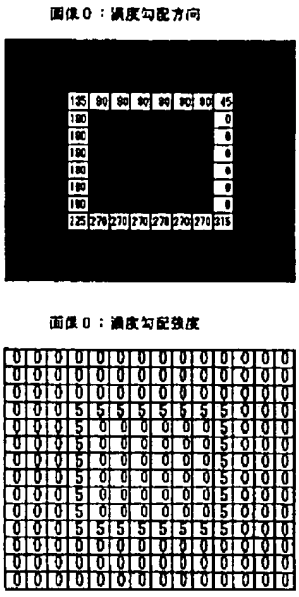


(a)モデル画像　(b)入力画像

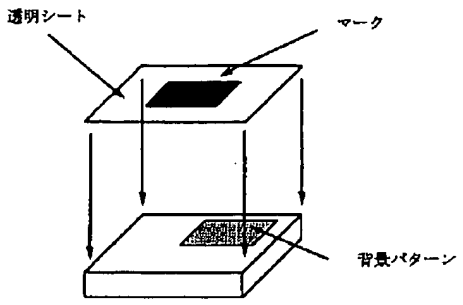
【図14】


スタート
ST1
NO
i＝ex－mx＋1
？
YES
ST2
NO
j＝ey－my＋1
？
YES
探索終了
ST3
i：＝i＋1
ST4
NO
i＝ex－mx＋2
？
YES
ST5
i：＝sx
j：＝j＋1
エ　ン　ド

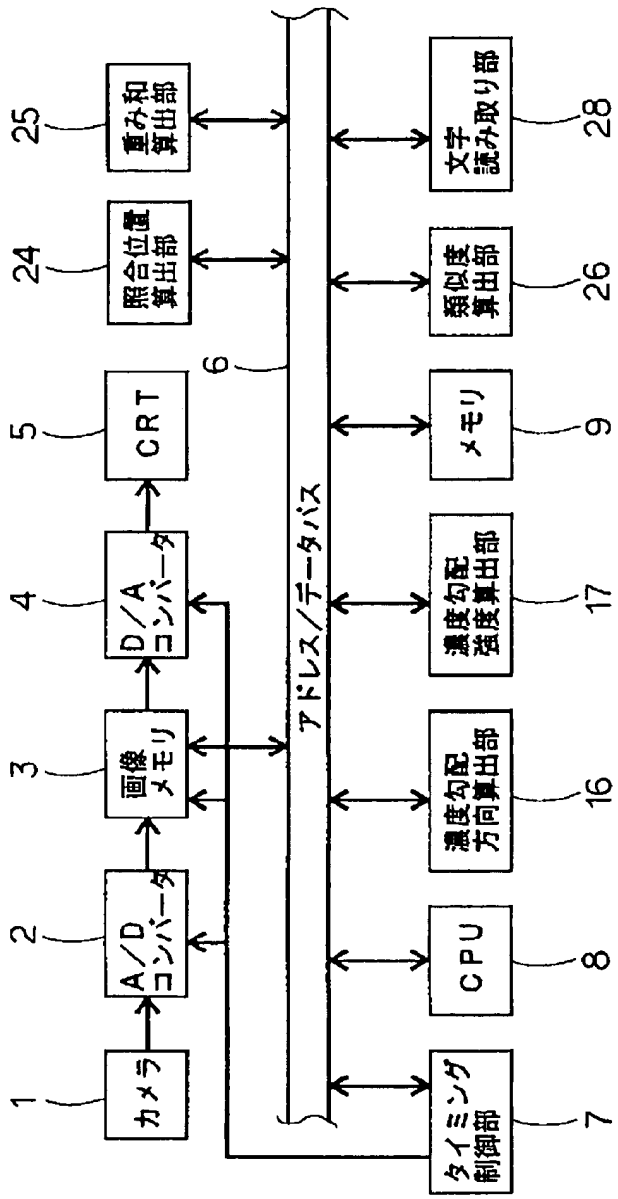
【図28】


画像0：濃度勾配方向
画像0：濃度勾配強度

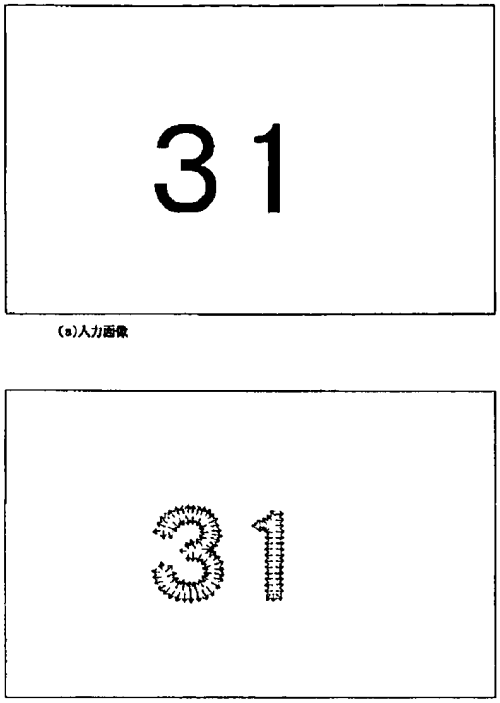
【図26】


透明シート
マーク
背景パターン

【図15】


1
カメラ
2
A/D コンバータ
3
画像 メモリ
4
D/A コンバータ
5
CRT
6
アドレス/データバス
7
タイミング 制御部
8
CPU
9
メモリ
16
濃度勾配 方向算出部
17
濃度勾配 強度算出部
24
照合位置 算出部
25
重み和 算出部
26
類似度 算出部
28
文字 読み取り部

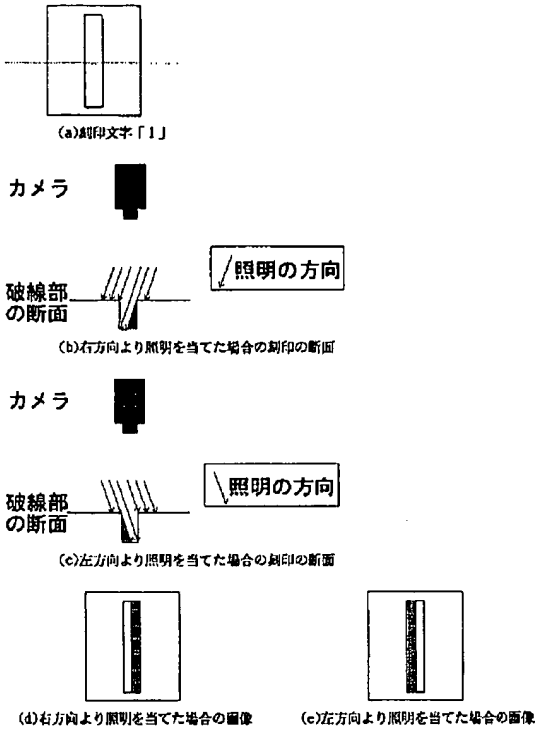
【図17】



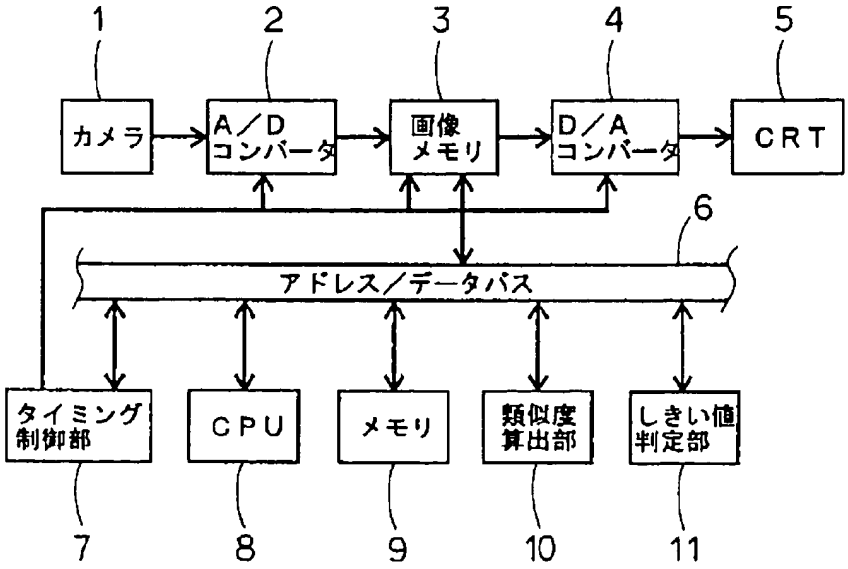
(a)入力画像

(b)入力濃度勾配方向

【図18】



【図23】



【図21】

ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	315	288	225	135	72	45	ND	ND
ND	ND	342	315	198	162	45	18	ND	ND
ND	ND	0	0	180	180	0	0	ND	ND
ND	ND	0	0	180	180	0	0	ND	ND
ND	ND	0	0	180	180	0	0	ND	ND
ND	ND	0	0	180	180	0	0	ND	ND
ND	ND	18	45	162	198	315	342	ND	ND
ND	ND	45	72	135	225	288	315	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(c)モデル濃度勾配方向($I\theta$)

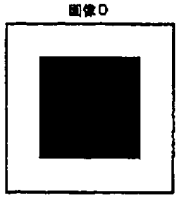
100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100
100	100	100	0	0	200	200	100	100	100
100	100	100	0	0	200	200	100	100	100
100	100	100	0	0	200	200	100	100	100
100	100	100	0	0	200	200	100	100	100
100	100	100	0	0	200	200	100	100	100
100	100	100	0	0	200	200	100	100	100
100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100

(d)入力画像

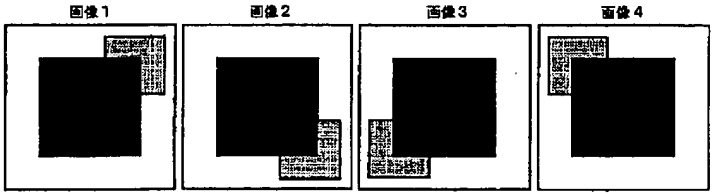
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ND	ND	135	108	45	315	252	225	ND	ND
ND	ND	162	135	18	342	225	198	ND	ND
ND	ND	180	180	0	0	180	180	ND	ND
ND	ND	180	180	0	0	180	180	ND	ND
ND	ND	180	180	0	0	180	180	ND	ND
ND	ND	180	180	0	0	180	180	ND	ND
ND	ND	198	225	342	18	135	162	ND	ND
ND	ND	225	252	315	45	108	135	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(e)入力濃度勾配方向($I\theta$)

【図27】



(無地の上にマークが重なっている)



(背景パターン上にマークが重なっている)

【図38】

代表濃度勾配強度

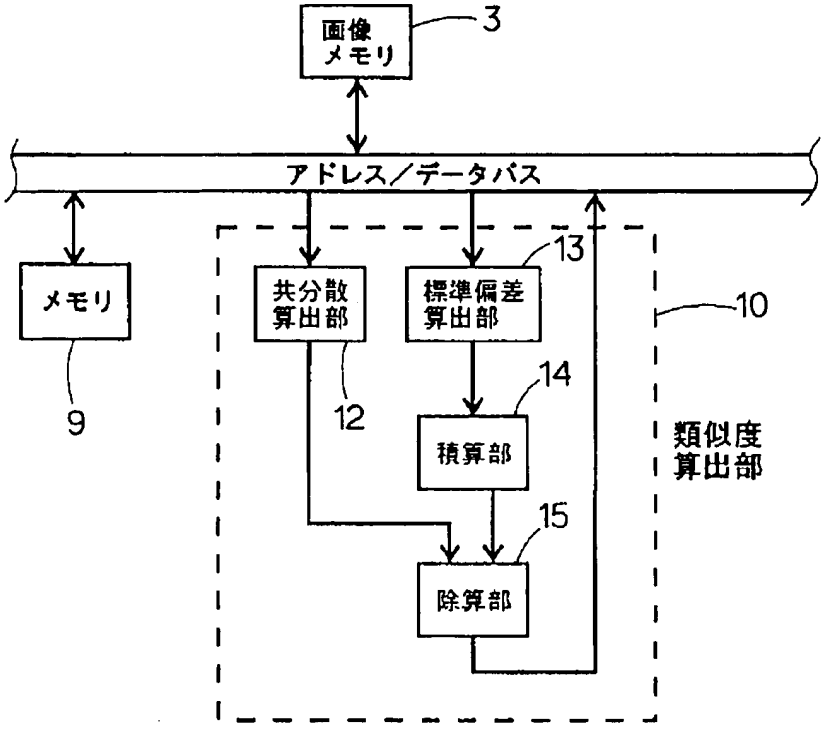
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00
0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00
0.00	0.50	0.00	4.50	4.50	4.75	5.00	5.00	4.75	4.50	4.50	0.00	0.50	0.00
0.00	0.50	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.50	0.00
0.00	0.50	0.50	4.75	0.00	0.00	0.00	0.00	0.00	0.00	4.75	0.50	0.50	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.50	0.50	4.50	0.00	0.00	0.00	0.00	0.00	0.00	4.75	0.50	0.50	0.00
0.00	0.50	0.00	4.75	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.50	0.00
0.00	0.50	0.00	4.75	4.75	4.50	5.00	5.00	4.75	4.50	4.50	0.00	0.50	0.00
0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00
0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

【図37】

代表濃度勾配方向

135	90	90	90	45			135	90	90	90	45		
180				0			180				0		
180		135	90	79	90	90	101	90	45		0		
180		180							0		0		
225	270	191							349	270	315		
		180							0				
		180							0				
135	90	169							11	90	45		
180		180							0		0		
180		225	270	281	270	270	259	270	315		0		
180				0			180				0		
225	270	270	270	315			225	270	270	270	315		

【図24】



【図39】

代表濃度勾配強度

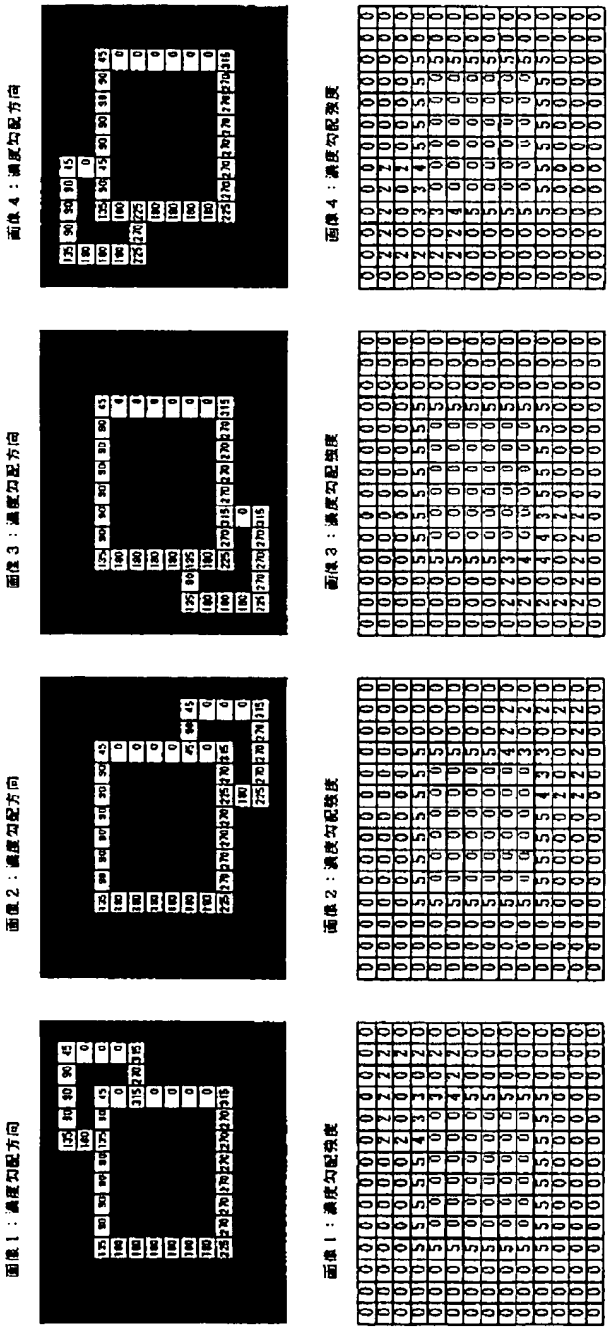
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00
0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00
0.00	0.50	0.00	4.50	4.50	4.51	5.00	5.00	4.61	4.50	4.50	0.00	0.50	0.00
0.00	0.50	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.50	0.00
0.00	0.50	0.50	4.61	0.00	0.00	0.00	0.00	0.00	0.00	4.61	0.50	0.50	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.50	0.50	4.30	0.00	0.00	0.00	0.00	0.00	0.00	4.61	0.50	0.50	0.00
0.00	0.50	0.00	4.75	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.50	0.00
0.00	0.50	0.00	4.75	4.75	4.30	5.00	5.00	4.61	4.50	4.50	0.00	0.50	0.00
0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00
0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.50	0.50	0.50	0.50	0.50	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

【図40】

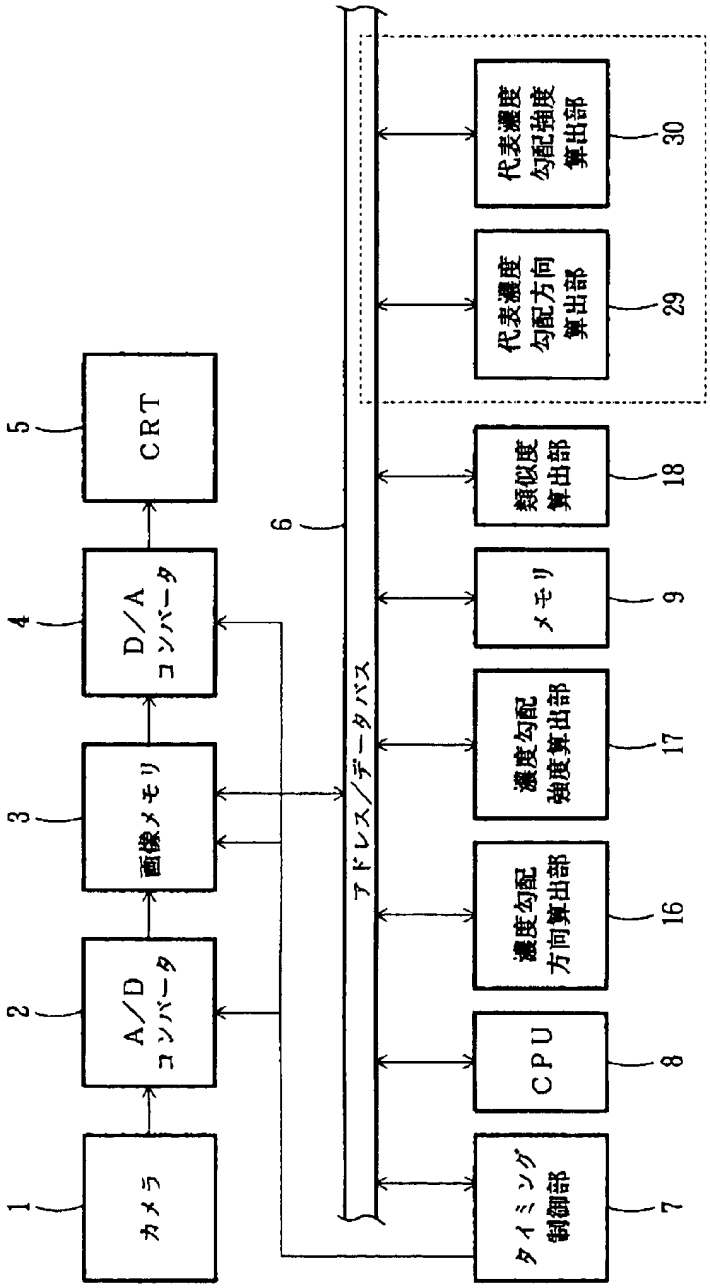
代表濃度勾配強度

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.13	0.13	0.13	0.13	0.13	0.00
0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.00
0.00	0.13	0.00	4.50	4.50	4.26	5.00	5.00	4.26	4.50	4.50	0.00	0.13	0.00
0.00	0.13	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.13	0.00
0.00	0.12	0.12	4.26	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.12	0.12	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.13	0.13	4.06	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.13	0.13	0.00
0.00	0.13	0.00	4.76	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.13	0.00
0.00	0.13	0.00	4.76	4.76	4.96	5.00	5.00	4.26	4.50	4.50	0.00	0.13	0.00
0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.00
0.00	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.12	0.12	0.12	0.12	0.12	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

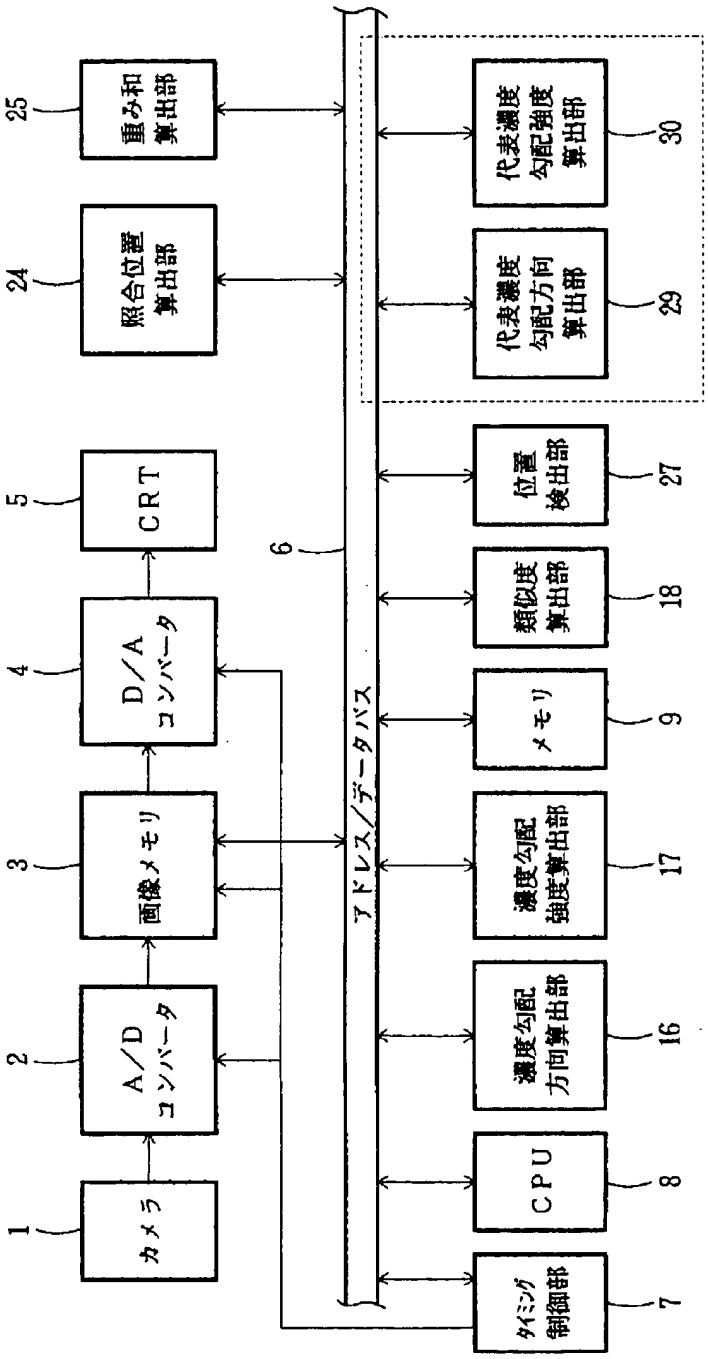
【図29】


画像1：濃度勾配方向
画像1：濃度勾配強度
画像2：濃度勾配方向
画像2：濃度勾配強度
画像3：濃度勾配方向
画像3：濃度勾配強度
画像4：濃度勾配方向
画像4：濃度勾配強度

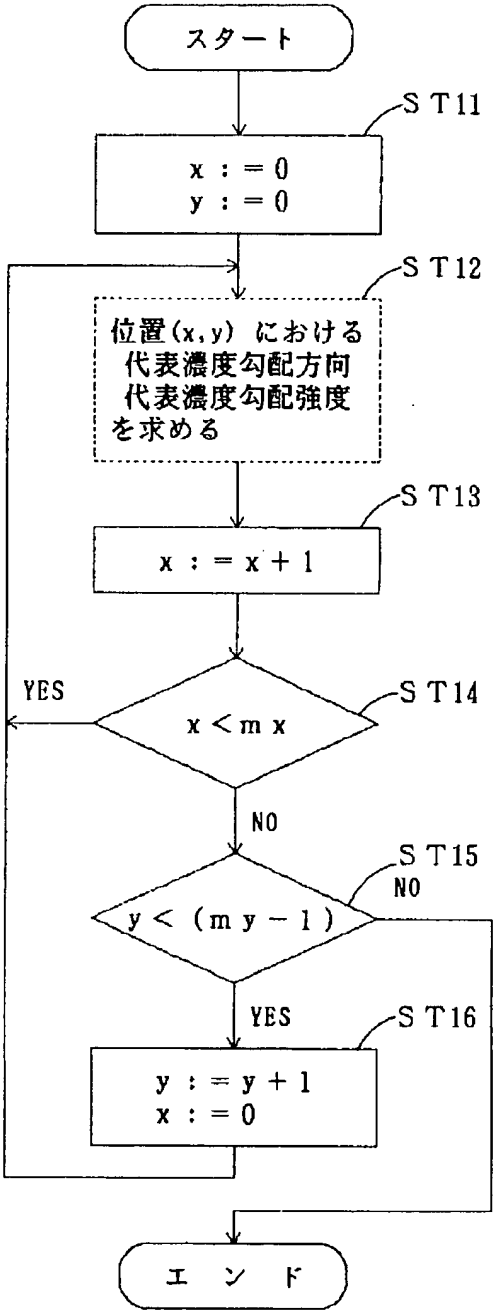
【図30】


1
カメラ
2
A／D コンバータ
3
画像メモリ
4
D／A コンバータ
5
CRT
6
アドレス／データバス
7
タイミング制御部
8
CPU
16
濃度勾配方向算出部
17
濃度勾配強度算出部
9
メモリ
18
類似度算出部
29
代表濃度勾配方向算出部
30
代表濃度勾配強度算出部

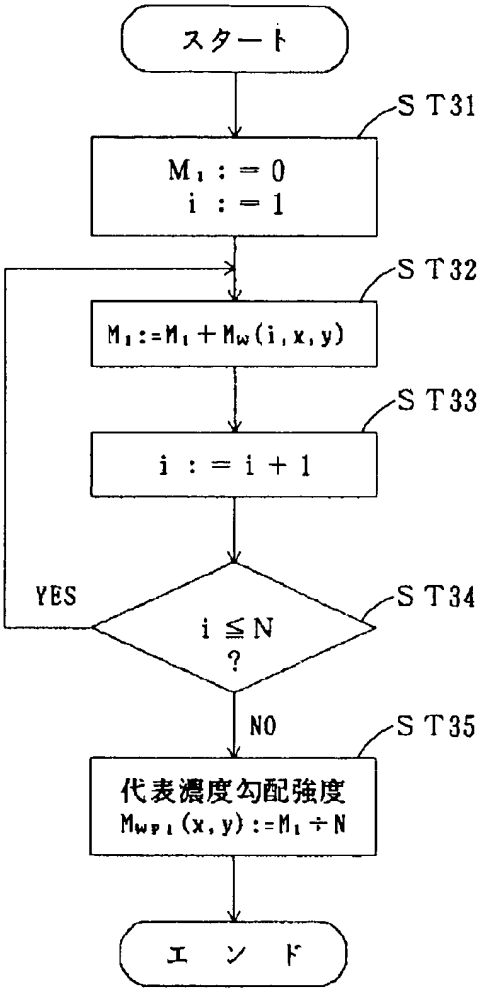
【図31】


1
カメラ
2
A／D コンバータ
3
画像メモリ
4
D／A コンバータ
5
CRT
6
アドレス／データバス
7
タイミング制御部
8
CPU
16
濃度勾配方向算出部
17
濃度勾配強度算出部
9
メモリ
18
類似度算出部
27
位置検出部
29
代表濃度勾配方向算出部
30
代表濃度勾配強度算出部
24
照合位置算出部
25
重み和算出部

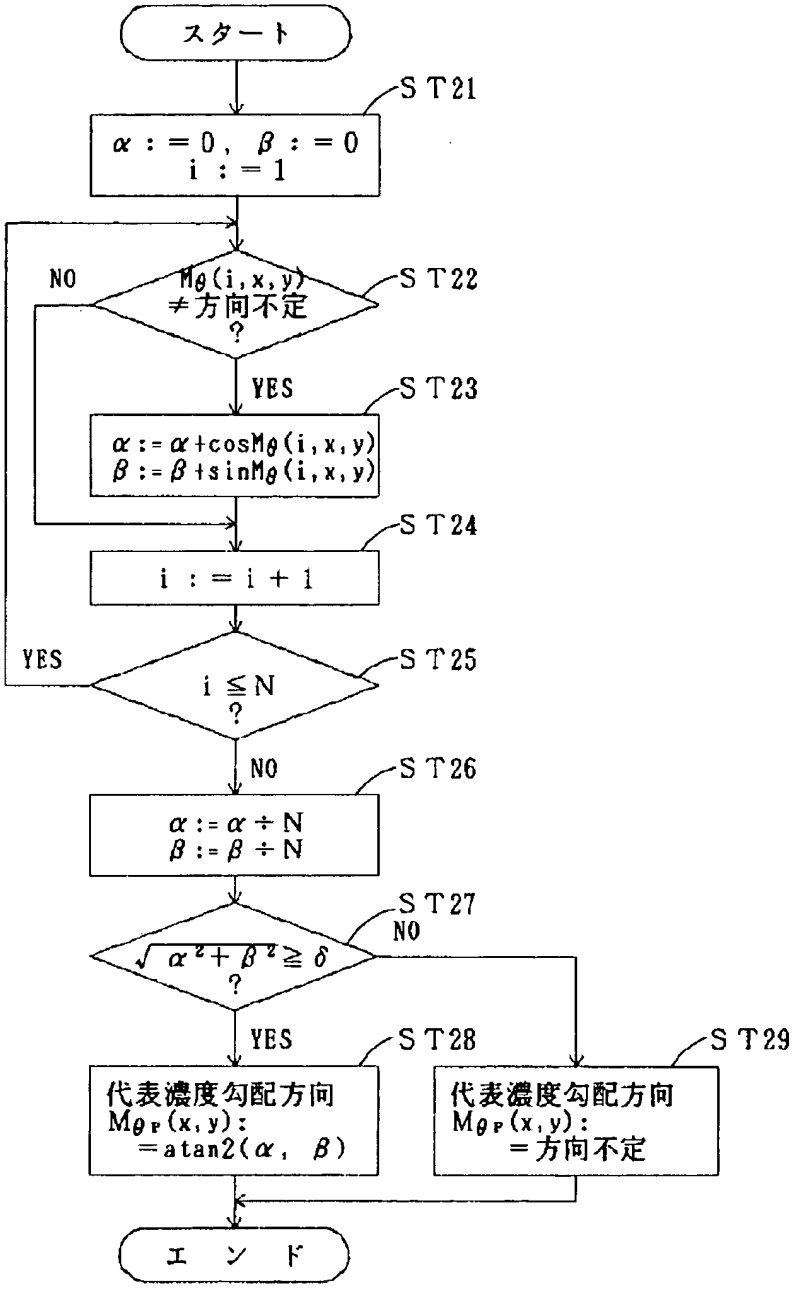
【図32】


スタート
S T11
x : = 0
y : = 0
S T12
位置(x,y) における
代表濃度勾配方向
代表濃度勾配強度
を求める
S T13
x : = x + 1
YES
x < m x
S T14
NO
S T15
NO
y < (m y − 1)
YES
S T16
y : = y + 1
x : = 0
エ ン ド

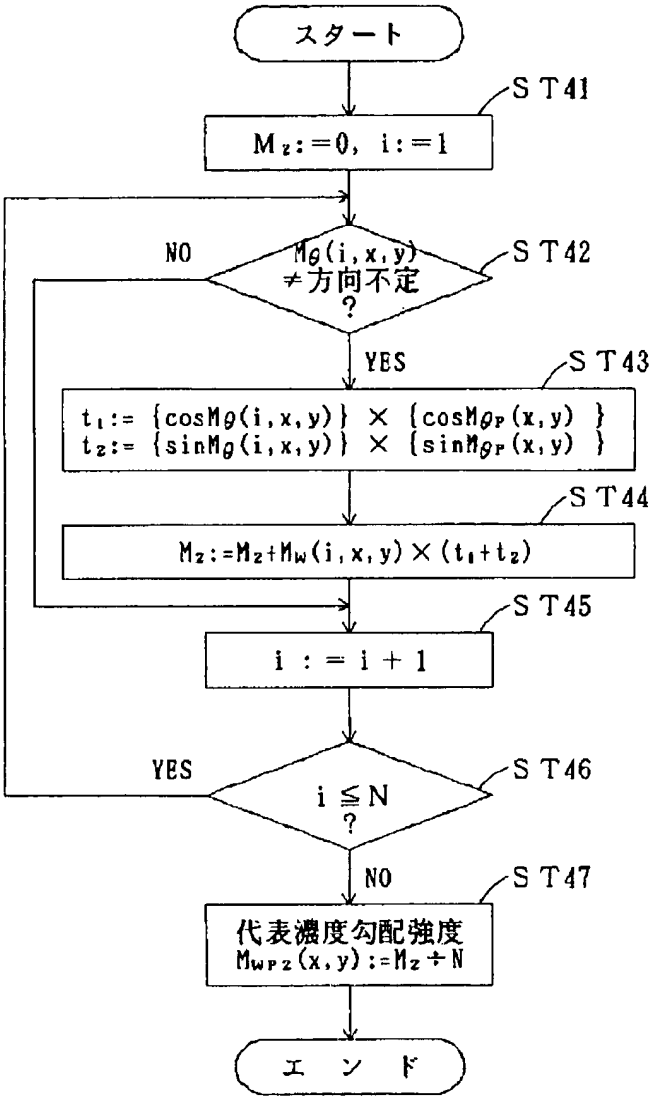
【図34】


スタート
S T31
M₁ : = 0
i : = 1
S T32
M₁ := M₁ + Mw(i,x,y)
S T33
i : = i + 1
YES
i ≦ N
?
S T34
NO
S T35
代表濃度勾配強度
Mwp₁(x,y) := M₁ ÷ N
エ ン ド

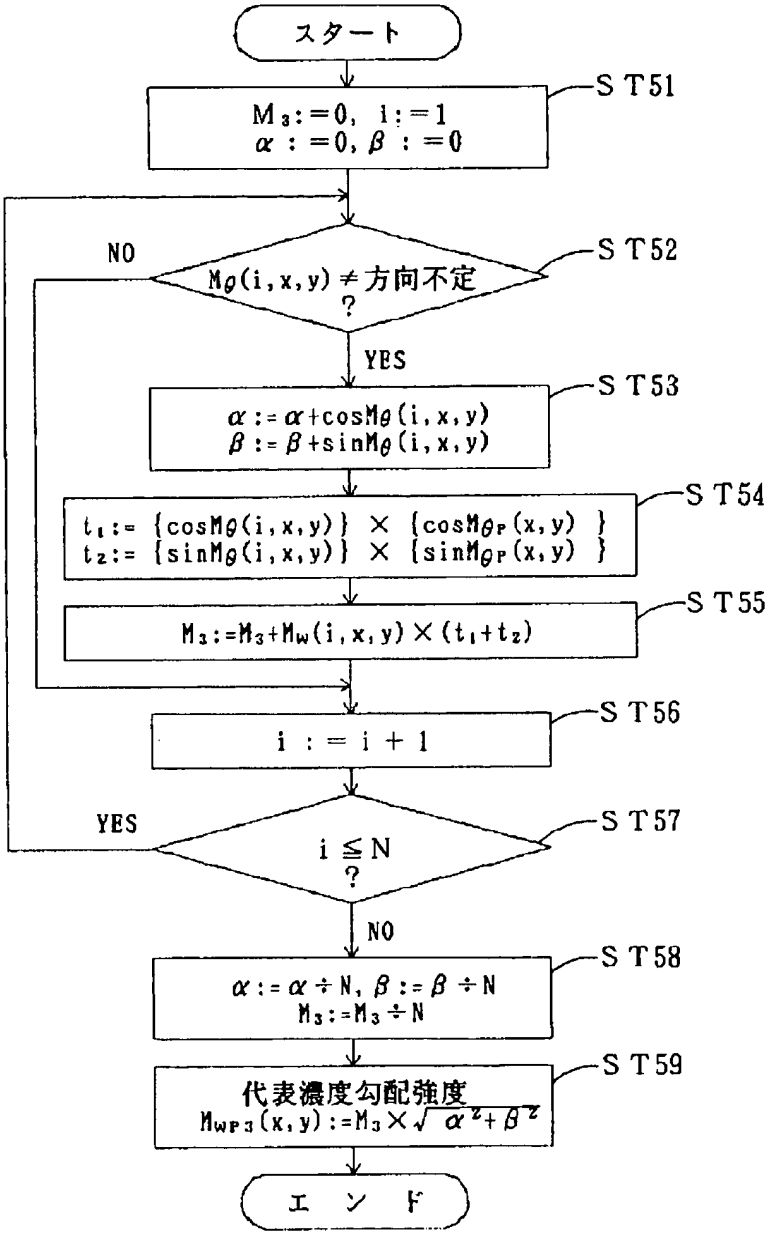
【図33】


スタート
ST21
α：＝0，β：＝0
i：＝1
NO
Mθ(i,x,y)
≠方向不定
？
ST22
YES
ST23
α：＝α＋cosMθ(i,x,y)
β：＝β＋sinMθ(i,x,y)
ST24
i：＝i＋1
YES
i≦N
？
ST25
NO
ST26
α：＝α÷N
β：＝β÷N
ST27
NO
√α²＋β²≧δ
？
YES
ST28
代表濃度勾配方向
MθF(x,y)：
＝atan2(α，β)
ST29
代表濃度勾配方向
MθF(x,y)：
＝方向不定
エ　ン　ド

【図35】


スタート
ST41
$M_z:=0,\ i:=1$
NO
$M_\theta(i,x,y)$ ≠方向不定 ?
ST42
YES
ST43
$t_1:=\{\cos M_\theta(i,x,y)\}\times\{\cos M_{\theta P}(x,y)\}$
$t_2:=\{\sin M_\theta(i,x,y)\}\times\{\sin M_{\theta P}(x,y)\}$
ST44
$M_z:=M_z+M_W(i,x,y)\times(t_1+t_2)$
ST45
i := i + 1
YES
i ≦ N ?
ST46
NO
ST47
代表濃度勾配強度
$M_{WPZ}(x,y):=M_z\div N$
エ ン ド

【図36】


スタート
$M_3:=0,\ i:=1$
$\alpha:=0, \beta:=0$
S T51
NO
$M_\theta(i,x,y) \neq$ 方向不定 ?
S T52
YES
$\alpha:=\alpha+\cos M_\theta(i,x,y)$
$\beta:=\beta+\sin M_\theta(i,x,y)$
S T53
$t_1:=\{\cos M_\theta(i,x,y)\} \times \{\cos M_{\theta P}(x,y)\}$
$t_2:=\{\sin M_\theta(i,x,y)\} \times \{\sin M_{\theta P}(x,y)\}$
S T54
$M_3:=M_3+M_W(i,x,y) \times (t_1+t_2)$
S T55
$i := i + 1$
S T56
YES
$i \leqq N$?
S T57
NO
$\alpha:=\alpha \div N, \beta:=\beta \div N$
$M_3:=M_3 \div N$
S T58
代表濃度勾配強度
$M_{WP3}(x,y):=M_3 \times \sqrt{\alpha^2+\beta^2}$
S T59
エ ン ド